

**THE WEB-BASED GRAPHIC SERVICE REQUEST SYSTEM
FOR FACILITY MANAGEMENT OF APARTMENTS**

A Thesis

by

KWANG JUN LEE

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE

August 2006

Major Subject: Architecture

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ABSTRACT

The Web-based Graphic Service Request System
for Facility Management of Apartments. (August 2006)

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This research investigates the feasibility of web technology as a means of handling service requests for delivering high quality service in building operation and maintenance. This research proposes a web-based graphic service request (WGSR) system as a pragmatic solution to the limitations of current computerized maintenance management system (CMMS) processes. Service request process in CMMS was developed as text-based, so that it is hard for ordinary tenants to use. Therefore, when tenants have a problem in a facility, they prefer calling in service requests or going to the office instead of using the internet service request application. In practice, work orders and records are often misplaced – resulting in lower efficiency and customer satisfaction. This may be overcome by a system that states information digitally and provides a web-based Graphic Service Request (WGSR) interface.

The interface allow customers to report environmental problems in the facility, trace their work order progress, view schedules for maintenance, and provide feedback for service online. The WGSR system is an end-user point-and-click graphical interface that allows residents to request service by selecting a problem fixture on a floor plan

image. By using HTML image map tags and combination of location, part, and types of problem identification number, the resident's input produces a text-based problem report for Facility Management (FM) departments that allows them to service requests on the fly. To solve the complexity and inefficiency issues of CMMS, the user interface for the WGRS system consists of a perspective drawing or isometric drawing of each unit's plan.

An empirical test of the system and post-task survey was conducted to determine the efficiency and usefulness of the system. The analysis of the results shows the system to be efficient and convenient in several fields, including comprehensibility, navigability, simplicity, clarity, compatibility, and graphic appeal. This result shows that residents prefer to use the WGRS system and could reduce the effort needed to make and receive service request phone calls and input information into a database. The labor and time for daily work could be saved to recognize problems correctly and set the right schedule so that this could be used for preventive work and project work.

DEDICATION

To my father, my mother, and the Lord – who give me endless love and support.

To my friends who keep believing in my ability.

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INTRODUCTION

Background Information

According to the definition by the International Facility Management Association (IFMA), Facility Management (FM) is a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, process, and technology (IFMA 2005). Process of integrating people, place, process and technology generates information in many fields, such as general facility planning and operations, asset management, maintenance and energy management, real estate management, space planning and management, engineering and construction. One of the strategies dealing with operation and maintenance information is a Computerized Maintenance Management System (CMMS). The effective implementation of the CMMS, or work management program, has become mandatory for facility departments. In recent times, all the major players in the CMMS marketplace are developing Web solutions (Thomas 2001). Since the Web-based CMMS has been developed with information technology (IT), the CMMS solutions help facility managers operate and maintain a facility better by dealing with facility information efficiently.

Moreover, being digital and making information active means findings new ways of talking to your customer base. The Internet in its various guises has provided an exciting opportunity for customer and service operation to interact (Thomas 2001).

This thesis follows the style and format of *Journal of Architectural Engineering*.

Better communication between customers and FM departments would deliver a high quality of service and improve the performance of service operations. In the current competitive age where information is readily available, service quality has become the focus of many organizations. This is because many companies have realized that satisfying the customer is the key to long term success (Pheng and Nguan 2004).

This research focuses on improving communication between customers and FM departments through the Internet to deliver high quality service for customers' satisfaction.

Present Status

Although CMMS is a good tool to deal with the operation and maintenance of a building, it has been developed for commercial complexes so that it is expensive to install, needs to have an operator, and is hard to adjust to other types of complex. Another problem is that service request process in CMMS has been developed as text-based, so that it is hard for the customer to use. Therefore, when the customer has a problem in a facility they prefer calling in for a service request or coming to the office instead of using the Internet service request application. The maintenance personnel manually enter this oral service request into their system, some times long after the phone call has been made (Federspiel 2003). Through this process, a report can be missed in shuffled papers or be forgotten to be documented. Most building operators obtain corrective maintenance information such as tenant complaints through a lengthy process that provides no feedback to the tenant (Fig. 1). In most buildings, occupants

never interface with operators and maintenance providers. Information may be dropped or not fully explained (TIEMS 2005).



Fig. 1. Process of service request (TIEMS 2005)

Occasionally individuals other than one of the primary points of contact report service requests to the maintenance organization (Federspiel 2003). Therefore, reports need to be organized for better performance and recorded for future reference in a digital way which is easy to retrieve.

Customers often feel that it is hard to request service because they cannot explain a fixture name or problem situation. Occupants usually explain the actual condition of problem, not the cause of problem. For example, when the resident said that the water in kitchen sink does not drain at all, it may be that drain pipe clogged up or the disposer is broken. The detailed part name of the fixture used in FM staff is jargon which occupants rarely use and even do not know. This causes the misunderstanding of a problem so that

staff cannot prepare the right material or tool to fix it. Therefore, it takes some time for facility manager to know where and what the problem is in the first place. This miscommunication causes not only a waste of time, money, and manpower of the FM administration, but also lost customer satisfaction.

From the point of view of FM administration, the staff is unable to repair the problem fully during the first visit sometimes. They might need to order material which is out of stock or have to call an outside contractor for professional assistance. When occupants were not at home or at the office with maintenance staff, they did not know why the staff could not fix the problem or when they will revisit to fix the problem. Tenants want to know the process of when maintenance staff comes to fix it, and what the reason for the malfunction is. In addition, customers feel bothered by the unexpected visiting of maintenance staff. Not only the scheduled preventive work or project work, the demand work schedule also should be sent to customers before it happens. Feedback on a resolution of the problem, feedback on quality assurance for the user, or feedback on the change in status of the work order is critical to the effective management of the facility. Changing the status of the work order to reflect what is happening can minimize the need for further calls and help provide quality customer service (Thomas 2001).

In order to solve the problems mentioned above, a Web-based Graphic Service Request (WGSR) system has been developed to facilitate communication between the customer and the FM department, and deliver a higher quality service for the customer's satisfaction.

Significance of Study

This research will help facility managers to decide whether or not the new Customer-centered CMMS has high performance and whether or not they can deliver service efficiently. Clayton et al (1999) mentioned in “Delivery of Facility Information to Support Operation Documents” that the phrase “delivery of facility information” has different meanings from different vantage points in the facility life cycle. The study address three phase to delivery of facility information;

- 1) delivery from consultants to the personnel
- 2) delivery from the information system to the operations and personnel
- 3) delivery from the operation personnel to the information system as feedback for quality assurance.

This research addresses one more phase to delivery of facility information from the customer to the information system. From the point of view of an FM department, it can be important that the customer participates in the FM process, because it stimulates the customer interest in the FM process and activities. Moreover, it decreases not only miscommunication among them, but also saves time from favoring digital work orders over oral requests to minimizes redundancies and inefficiencies. The application of this system will provide a way for applying continuous improvement in the FM approach to service requests.

LITERATURE REVIEW

The literature review is divided into the three following areas of concern: first, studies dealing with impact of IT on FM practice; second, studies dealing with customer satisfaction for high quality service delivery; third, studies dealing with research methodology to guide graphic user interface with design principles, and to collect and analyze the survey data.

Impact of Information Technology on Facility Management Practice

The nineteenth century brought about a sudden alteration in culture with the collaboration between science and its applied means or knowledge – “technology”. Subsequently, in the twentieth century, this new culture has transformed our normal life style and we can perceive the development of civilization sensuously (Kim 2002). This initiated development in Information Technology (IT) since the personal computer boom in the 1980’s. IT has changed, and affects, every phase of industry and academia. In Architecture/Engineering/Construction (AEC) industry and academia, the importance of IT has been phenomenal over the past few years (Pena Mora, et al 1999). For facility management, IT supports new strategies and solutions in every stage – such as real estate, operation, and maintenance. New information technologies enable the creation of improved information systems that can better deliver facility information.

The CMMS, one of new strategies and solutions of FM in IT, can help increase the quality of customer service and help in managing resources efficiently as an organization maintains its asset base (Thomas 2001). The earlier computer-aided facility management

(CAFM) systems were desktop solutions whereby data was moved over a local area network (LAN) to the desktop PC. The process through a LAN tended to be slow and restricted their use to mostly inventory management and reporting applications (Teicholz, 2001). CMMS can bring value at several levels – it provides a vehicle for improving customer service and a roadmap for staff to follow in providing service. It provides a benchmark to show whether the facility manager has met the level of service or has improved service (Thomas 2001).

In recent times, widespread use of Internet technologies has resulted in an increasing number of Web-based applications in the AEC industry (Wang and Wu 2000). Implementing Internet technologies for FM application provides the facilities manager with decision-making information. It started with initial basic information sharing such as electronic mail, file transmission protocol and on-line application sharing for exchange of CAD files. Moreover, electronic commerce, on-line collaboration and telecommuting has been developed and implemented in the fields of space, asset, project, fleet, lease and property management in FM. Although Internet technology continues to grow and change rapidly, it is no longer considered bleeding edge. In fact, more likely it is considered to be a required and often a strategic technology. Therefore, it is important for facilities managers to have new tools to assist them in solving problems related to a building; they must also have a technology plan (Cox 2001).

The Customers' Satisfaction for High Quality Service Delivery

In surveys conducted by IFMA, customer service is still the number one concern of facility managers. Once an FM organization understands the critical role that ultimate customer service plays, it becomes a goal that most FM organizations strive to achieve (Thomas 2001). The next step for customer service knows what customers' exact requirement, needs, and wants are. Then facility managers can define quality FM services and structuring service delivery accordingly with involving customers in the service delivery process (Friday 2001). Tenants, like sensors, are sources that can provide real time environmental information. The challenge is to collect, archive, and analyze this information in a manner that enhances operator responsiveness and then act on it to improve building operation (TIEMS 2005). After service delivering, assessing customers' satisfaction level with service delivery increases the performance of FM personnel. Customer feedback should be linked to continuous service delivery for the improvement process. Using this information wisely, the facility manager can develop a methodology to measure key performance indicators over time to provide benchmark statistics on how the department is providing service (Thomas 2001).

A service request is the first contact point between tenants and FM administration. Usually, service requests submitted by phone are entered into the maintenance database by hand, so it is possible that some service requests submitted by phone are not recorded. In order to avoid this mistake and improve the process of work orders, there is the practice of entering all service requests through a user interface which automatically enters into the maintenance database and is flagged as originating from the user interface.

The case study of “Request For Facilities Services System (RFFS)” by the CRS Center at Texas A&M University describes the approach used by one facilities department to organize the work requests and management process (Fig. 2). The reported benefits of the automation of the RFFS are (Johnson and Clayton 1997):

1. Calls to the office administration personnel were reduced substantially, since the status of all projects is available on the system.
2. The system increased the ability to track projects so that they do not get lost in the paper shuffle.
3. The system keeps the history of the project for review at a later date, if required.

Date Requested:						
Work Information						
OAF/DE Approver				Key Contact		
<input type="text"/>				<input type="text"/>		
Division				Dept. Charge	Project Description	
<input type="text"/>				<input type="text"/>	<input type="text"/>	
People	Box Moves	Furniture Moves	Construction	Cost Estimate		
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="radio"/> Yes <input type="radio"/> No		
Occupant Information						
Last Name	First Name	Phone Nbr	Curr Loc Addr	Curr IP Id	Keylock Nbr	Requested Completion Date
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

Fig. 2. Data entry form for RFFS

In addition, UC Berkeley researchers designed computer software (the Tenant Interface for Energy and Maintenance System or TIEMS) to collect and manage information from tenants more efficiently. Providing tenants with a user interface to energy and maintenance systems improved thermal comfort, improved the performance of energy management strategies, eliminated some redundant service requests, and improved the quality of data in the maintenance database. A well-designed user interface should also improve the satisfaction of the occupants with the services provided to them by maintenance personnel (Federspiel 2003).

Despite of the benefits of the automation of the RFFS and TIEMS, they were developed on a text-based system and for expertise use of FM administration. The tenants who occupy the facilities use the same interface which facility operation personnel use for their tasks, so it is not user friendly and it is hard to request facility service in many cases.

Graphic User Interface Design Principles

In order to overcome the disadvantages of the present service request systems, a Web-based Graphic Service Request (WGSR) was developed in this research. The user interface is a key issue for this project to overcome other systems' disadvantage. A user interface can be defined as a collection of techniques and mechanisms to interact with something (Galitz 2002). The elements that the user interacts with are referred to as objects. Objects are always visible to the user and a user can perform tasks using them (Darapureddy 2001). Some of the principles of good interface design are derived from

the various principles described in Galitz (1992), IBM (1991, 2005), Mayhew (1992), Microsoft (1992, 1995, 2005), Open Software Foundation (1993), and Verplank (1988).

- Aesthetically pleasing – Visual appeal makes a computer system accessible and inviting. Visual appeal is terribly important today because most human-computer communication occurs in the visual realm. Visual appeal is provided by providing meaningful contrast between screen elements, aligning screen elements, providing three-dimensional representations, and using color effectively.
- Clarity – The interface should be understandable in visual appearance, concepts, and wording. Visual elements should be understandable. Interface words and text should be simple, unambiguous, and free of computer jargon.
- Compatibility – User interface provide compatibility with the user, the task and job, and the project. For user compatibility, design must be appropriate and compatible with the needs of the user or client. Common error among developers is to assume that users are all like, and think feel, and behave exactly. Adopting the user's perspective is the fundamental principle in interface design. For task and job compatibility, the structure and flow of functions should permit easy transaction between tasks. The user should be allowed to navigate freely between applications or many screens to complete routine daily tasks. For product compatibility, the intended user of new system is often the user of other system or earlier version of the new system. Making new systems compatible with existing system will take advantage of what users already know and reduce the necessity for new learning.

- **Comprehensibility** – A system should be easily learned and understood. The flow of actions, response, visual presentations, and information should be in a sensible order that is easy to recollect and place in context. The steps to complete a task should be obvious.
- **Simplicity** – The interface should be as simple as possible. This can be achieved by hiding some of the elements and functions until needed, minimizing visual complexity by reducing the number of screen alignment points, and by providing uniformity and consistency. It is better to provide less functionality that will get effectively used than to provide too much functionality, yielding an interface hopelessly complex and extremely difficult to use.

Collecting and Analyzing Data

Survey questionnaires are the most frequently employed data collection tactics used in correlational research. The advantage of survey questionnaires is that they enable the researcher to cover an extensive amount of information (e.g. demographic characteristics, behavioral habits, opinions or attitudes, etc.) across a large number of people in a limited amount of time (Groat 2002). A few types of survey questions or other measures that are commonly used are derived from the various principles described in Newsom (2006), Groat (2002), and Usabilityfirst (2006).

- Yes/No Questions

Any question on a survey that has yes or no as a possible response is nominal, and so binomial statistics will be applied whenever a single yes/no question serves as the dependent variable or one of the dependent variables in an analysis.

- Likert Scales

Other survey questions use a set of responses that are ordered so that one response is greater than another. The term Likert scale is named after the inventor, Rensis Likert, whose name is pronounced "Lickert." Generally, this term is used for any question that has five or more possible options. For example: "How would you rate your department administrator? 1 = very incompetent, 2 = somewhat incompetent, 3 = neither competent nor incompetent, 4 = somewhat competent, or 5 = very competent." In software evaluation, the researcher can often objectively measure efficiency and effectiveness with performance metrics such as time taken or errors made. Likert scales and other attitudinal scales help get at the emotional and preferential responses people have to a design.

- Physical Measures

Most physical measures, such as height, weight, systolic blood pressure, distance, etc., are interval or ratio scales, so they fall into the general "continuous" category.

Therefore, normal theory type statistics are also used when such a measure serves as the dependent variable in an analysis.

- Counts

Counts are complicated. If a variable is measured by counting (case.g. if a researcher is counting the number of days a hospital patient has been hospitalized) the variable is on a ratio scale and is treated as a continuous variable; thus, normal theory statistics, like t-tests or correlations, are used. If a researcher is counting the number of subjects in an experiment (or number of cases in the data set), a continuous type measure is not really being used. Counting in this instance is really examining the frequency that some value of a variable occurs.

There are key issues that a researcher must address in developing a survey questionnaire. They should first determine the main topic to be covered and clarify the purpose of each question. Response format must also be considered; that is, if closed vs open-ended format is more advantageous. Researchers must also clarify phrasing in the questions; a survey should use short sentences, employ non-threatening language, and avoid making two queries in a single question, framing questions in the negative, and using ambiguous wording. Question order should follow a logical sequence of topics, starting with interesting and non-challenging issues, and should not place an important item at the end of a long survey (Groat 2002).

After collecting data from empirical tests and post-task surveys, analyzing data should follow a statistical and measured scale, (which is essentially the assigning of numbers to observations according to certain rules). The way in which the numbers are assigned to observations determines the scale measurement being used. The choice as to

which statistical test can legitimately be used for data analysis rests largely on which scale of measurement has been employed. Further, the inferences that can be drawn from a study cannot, or at least should not, outrun the data being used.

- Categorical Measurement and Nominal scale

In categorical measurement, the variable of interest is sorted into discrete categories, based on verbal or nominal terms (Groat 2002). Nominal measurements reflect only differences in kind, not differences in degree or amount. With nominal data, neither the mean nor the median can be used, since each of these measures implies comparisons of greater than and less than. The only measure of central tendency permissible for nominal data is the mode, the most frequently occurring score (Dobbin and Gatowski 2006).

- Ordinal Scales

Ordinal measurement provides a greater degree of precision than categorical classification in that the variable in question can be ordered on some basis (Groat 2002). Since ordinal data provides no information regarding the distance between the scale points, calculating an ordinal mean is inappropriate and misleading. When ordinal data is used, only a median should be calculated.

- Interval and Ratio Scales

A more precise measure is one that specifies the exact distance (or interval) between one measurement and another. Any system that relies on an established and consistent unit of measurement (e.g. dollars, feet, or degree of temperature) satisfies the criterion of an interval scale. However, the validity of measuring attitudes and feelings on an

interval scale is a topic of much discussion and disagreement (Groat 2002). With interval and ratio data the difference between scores is equal, so such data allows for the calculation of the mean, median, and mode (Dobbin and Gatowski 2006).

Using the Internet to collect and analyze data has become an increasingly popular technique in recent years (Ballard and Prine, 2002; Bandilla, et al 2003; Dillman, 2000; O'Neil and Penrod, 2001; Sills and Song, 2002). This has led to a fairly sizable body of research that compared the effects of utilizing web-based surveys versus paper-based surveys to collect data (Cook, et al 2000). One primary finding that has emerged from research examining the differences in web-based and paper-based surveys is that the response rates are similar and in some cases higher for web-based surveys (Carini, et al 2003; Cook, et al 2000). Using the Internet to collect data has the potential to increase efficiency in the data analysis process with respect to cleaning and coding data for use in data analysis software programs (Berry, 2005; Cronk and West, 2002).

METHODOLOGY

The research methodology develops the feasibility and concept of the WGSR system for work requests and work order management. This research consisted of three phases: literature review, software development, and empirical testing.

Research Hypothesis

Hypothesis 1:

There exist communication issues that cause residents to hesitate to report problems and create obstacles for FM organizations to recognize those problems correctly.

As mentioned in the introduction section, residents often feel that it is hard to request service because they cannot explain a fixture name or adequately describe a problem situation. It takes some time for facility managers to know where and what the problem is in the first place. This miscommunication wastes not only of time, money, and manpower in the FM administration, but also lowers resident satisfaction. Through this research, the way to improve communication between residents and FM departments will be studied and developed.

Hypothesis 2:

Residents will prefer to use the Web-based Graphic Service Request System to submit a request for services.

Residents contact the FM office by telephone, email, or walk in. As information and Internet technology advanced, people can connect to the Internet anywhere and

anytime 24/7 to request service with a personal computer. There are many text-based service request application in CMMS developed in that market, but none are graphic-based. As mentioned earlier, however, existing systems are too expensive to buy and install, and are hard to use for ordinary people such as residents. Through this research, the possibility of developing a user-friendly and scalable Web-based Graphic Service Request system is tested.

Process of Development in the Prototypes

The interface allows the customer to report facility problems, trace work orders in progress, view schedules for maintenance, and provide feedback for service online by using a Graphic User Interface (GUI). A five step model of the prototyping process is illustrated in Fig. 3.

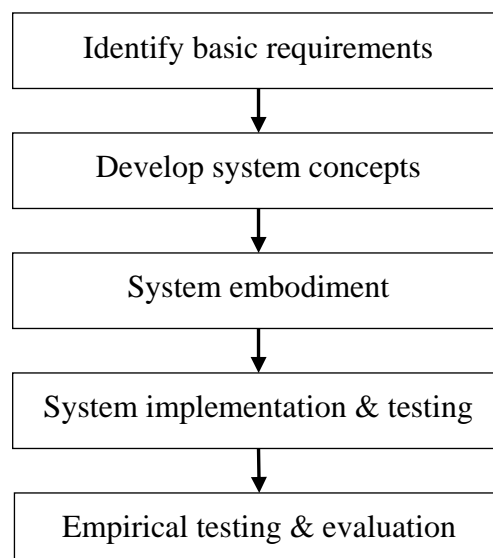


Fig. 3. Process of development in the prototype

The research method consists of the following steps:

Step 1. Identify Basic Requirement

This step identifies the basic needs of users for the system. Three sources of information were used to define and compose the structure of the user interface:

- Historical daily operation and maintenance records.

What types of requests do residents report? The types and volume of requests will be analyzed. Federspiel (1998, 2001) analyzed maintenance records from hundreds of buildings, covering a duration of several years in total. His analysis shows that 75% of environmental complaints reported by occupant and recorded in maintenance databases involve thermal conditions (Federspiel 2001). However, the subject of this research will be the occupant in a residential complex and they control the thermal condition on their own, so that type and volume of complaint is different from tenants in office buildings.

- Interview with FM staff

FM staffs are asked about the communication methods and problems between the customer and FM department, and the process of service delivery such as making the request to work order and performance of the work order. The problem of communication and service delivery will be analyzed.

- Interview with the occupants

What kinds of problems occur often in their unit? How do they report their problem to the FM department? The satisfaction of service and the relevant

information is collected for answering the above questions to support the approach in this stage.

Step 2. Develop System Concepts

At least three alternative ways on the Internet are available to be used for conveying information among multiple parties. They are e-mail, File Transmission Protocol (FTP) and Web-based file folder system (Buzzsaw 2002)

- E-mail

E-mail is used as common way to send messages and attachment files. The case study of “The impact of IT on FM practice” by the CRS Center at Texas A&M University shows that the overwhelming acceptance of the usefulness of e-mail reported in Fortune 500 survey and confirmed by site visits raises some interesting possibilities for enhancing communication and collaboration within FM organization (Al-Qawasmi, et al 1997). However, it is difficult to check whether the message and attachment files have arrived at the destination. The minimum object that is handled in them is a piece of message, but the construction practice needs to handle the contents of the message and/or files, i.e. information items.

- File Transmission Protocol (FTP)

FTP is used to send files to a specified FTP server, which can be made visible for multi-party use.

- Web-based file folder system

While these two ways provide only the basic functions for conveying information, Web-based file folder systems provide further capability. It allows the establishment of a work space in the form of a folder tree of files, and the assignment of a super user to maintain the structure of folder tree. The super user can define normal users and their right to access the files under the folder tree in such manners as browse, upload, and download. In this way, the defined users can use the specified workspace to convey information. However, the user has to be aware of the location for storing the message and files when he wants to store the information hierarchically, while it is desirable that the information be stored in a hierarchical structure automatically (Zhiliang et al 2004).

The above-mentioned ways are insufficient for conveying exchanged information in operation and maintenance for several reasons. In order to solve these problems, the approach adopted in this study is to develop a Web-based system for the management of exchanged information in a Web-based Graphic Service Request System.

Step 3. System Embodiment

This step defines the relationship about the basic requirements and organizes a hierarchy of these for the structure of a database. The Entity Relation Diagrams (ERDs) will be used to show the relationship more clearly. ERDs have three basic elements: entity types, relationships, and attribute. Entity type is a collection of entities (person, place, events, or things) of interest represented by a rectangle in an entity relationship

diagram. Attribute is a property of an entity type or relationship. Each attribute has a data type that defines the kind of value and permissible operation on the attribute.

Relationship is a named association among entity types. A relationship represents a two-way or bidirectional association among entities. Most relationship involves two distinct entity types (Mannino 2004)

Step 4. System Implementation and Testing

Currently there are two main popular Web servers available, Apache by the Apache Server Foundation on the UNIX system, and IIS (Internet Information Services) server by Microsoft on the Windows system. In the UNIX system, generally PERL (Practical Extraction and Report Language) and PHP (Hypertext Processor) are used; ASP (Active Server Pages) is used in the Windows system as a programming language. Various brands of databases are being used, such as MS Access database, MYSQL server, MS-SQL servers, or Oracle databases. Each database has its own features and characteristics. Usually database selection is based on the size of data, the number of users, and the amount of accessing traffic (Webopedia 2005). Most Internet users use a Windows system for network services. Therefore, IIS server, ASP programming language, and MS Access database were selected to develop the system. Test will be performed first by the developer to fix bugs which occur during the process of entering and retrieving data.

Step 5. Empirical Testing and Evaluation

This step evaluates the system's logical and physical concepts. Residents of Texas A&M University apartments will be chosen for the test group. There are many work orders generated, such as the demolition of College Avenue Apartments, inspection and renovation of gas pipe lines, as well as daily basis demand work. This creates a large amount of information to be delivered between residents and FM administration. Therefore, university apartments will be a good group to test the concept of the system. There are four types of apartment in Texas A&M University apartments (Avenue A, College Avenue, College View, and Hensel). Each apartment has a different floor plan so this will be good for comparison. Residents of College View and Hensel terrace apartments will be chosen for testing due to time limitations.

After the empirical test, a Web survey in the form of a questionnaire will be given to residents to ask about the usefulness of the system. The survey results will be helpful in evaluation of the system and its future development.

SYSTEM DESIGN

User Model

The user interface design is developed based on how users will use the system and for what purpose. Fig. 4 illustrates the concept of the Web-based Graphic Service Request system in the flow chart which is divided into three sections:

- The authentication section – it allows users to login and assigns them an access level
- The service request status section – it shows the process of service requests
- The report section – it creates a new service request for each unit

The system assigns three levels of authorization, 1, 2 and 3. Level 1 is for residents. The management of the data for level 2 and 3, which is for operation and maintenance staff, is a work in progress with methods demonstrated and proven by Jin Su Jeong (2006, Work in progress) in department of architecture at Texas A&M University. Therefore, this research deals only with service request from the point of view of the resident for easy reporting and checking the process of the work order.

The residents are grouped according to apartment types and get authentication for their access. In the report section, an image file of the floor plan is retrieved according to each resident based on their type of apartment.

The user interface is the part of the software program that allows users to interact with computers and carry out their tasks (Ratanamonkasem 2000). The purpose

of the interface design of WGSR is to provide graphical forms, which interact with the users and assist them in reporting problems and accessing the status of their work order, as well as other data stored in the system. The user interface for this prototype is designed based on the logical sequence of functions described in Fig. 4. The interface design specifications of the WGSR system are composed of simplicity, efficiency, and feedback. In terms of simplicity and efficiency, the WGSR system uses a graphical interface instead of a text-based service request form. As mentioned in the present status section, most of the Computerized Maintenance Management Systems consist of text-based forms for reporting the problems in facility environments.

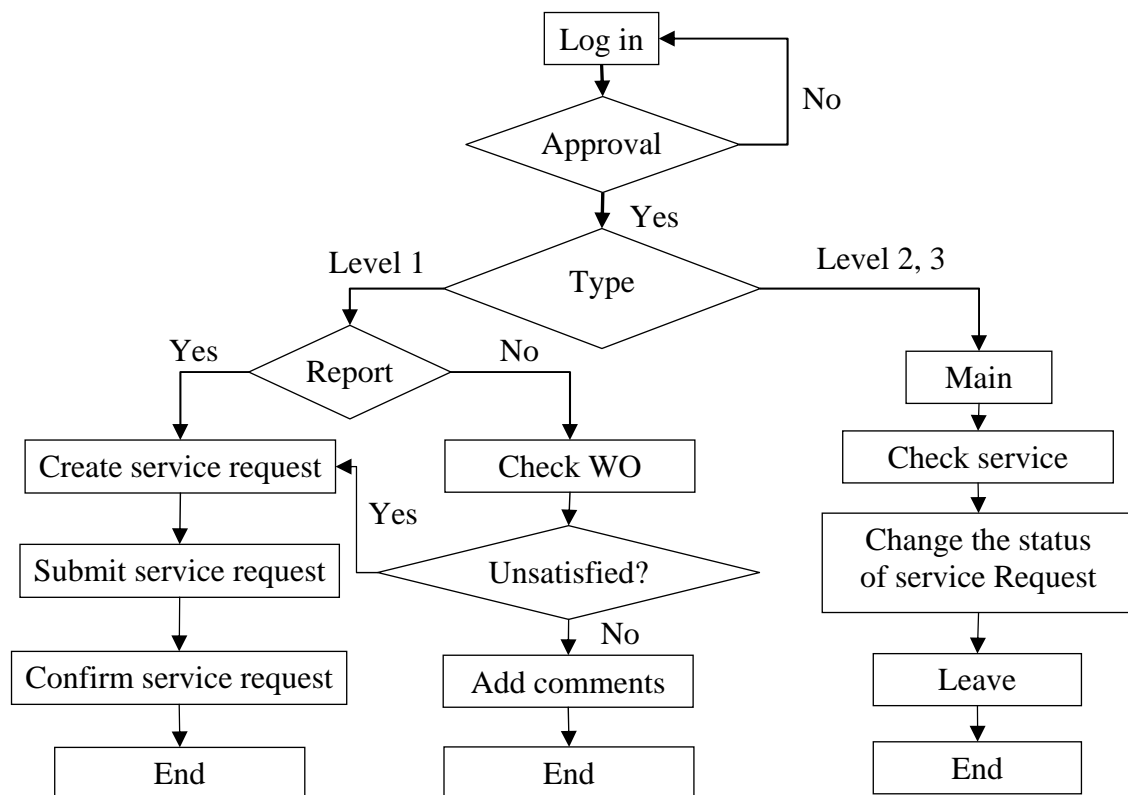


Fig. 4. Structure of user model

Fig. 5. Customer request page for on-campus dormitory of Texas A&M University

Occupants have to select buildings from drop-down menus or type the name of their building. For detail, they also write down all kinds of information about their problem (Fig. 5). To solve this complexity and inefficiency, the user interface for the WGRS system consist of a perspective drawing or isometric drawing of each units' plan. To input their service request, the residents will just click the part of drawing where the problem occurs. An image map tag in HTML assigns an identification number on each a part of drawing so that it linked not only to a detailed drawing for the next steps, but also to store the identification number into system where the problem happened (Fig. 6).

In terms of feedback, the system provides feedback and error messages to inform users about their interaction with the system. These messages tell the users about what they are doing and assist them to do it properly. For instance, if the users input the wrong

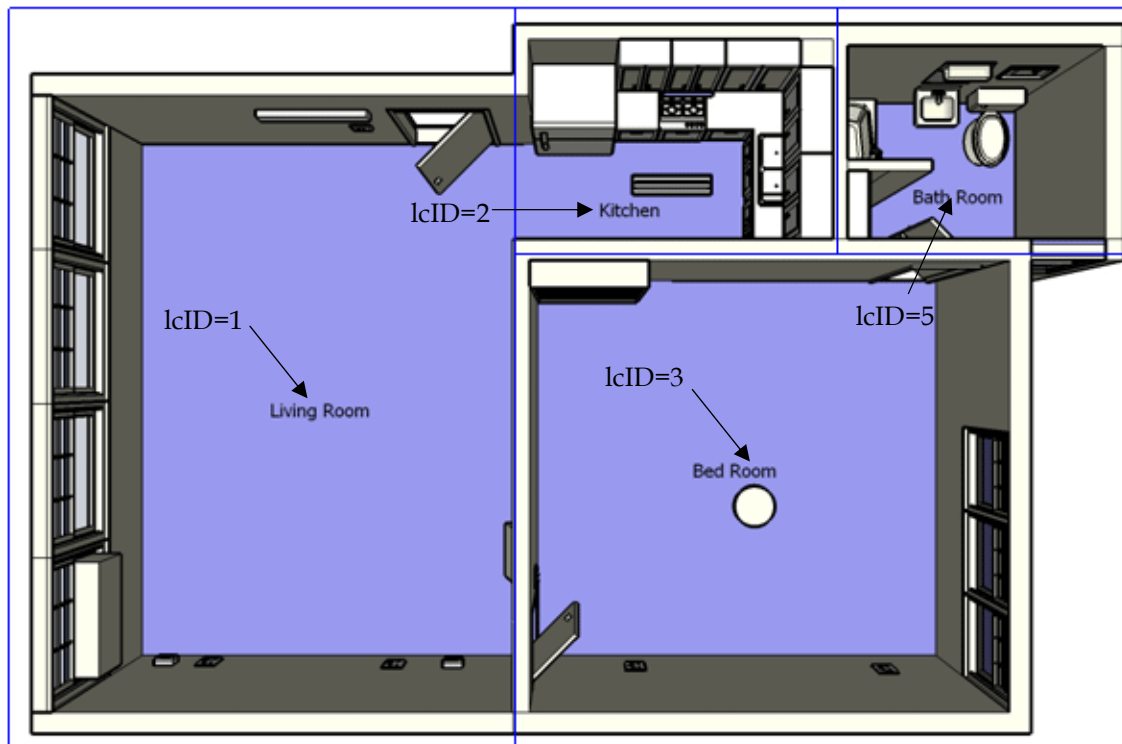


Fig. 6. Identification number for each room

ID and password, an error message shows up. If the resident forgot to input information, an error message pops up before prompting for the next instruction.

Conceptual Model of the WGSR

The Web-based Graphic Service Request System is a tool to report problems with various options, and is supported by a graphic image, view history, and status of service requests. The system is designed to support two types of users: residents and facility management staff.

Three-tier structure is used (Fig. 7). It is assumed that the department of facility management or the authorized Internet Service Provider (ISP) maintains a Web server

and the Database Management Systems (DBMS) are installed on the database server. The client computer used by the multi-party are required only to install a Web-browser and connect to the Internet. The users can connect with the system through the layer of user interfaces such as Internet Explorer, Mozilla FireFox, or Netscape.

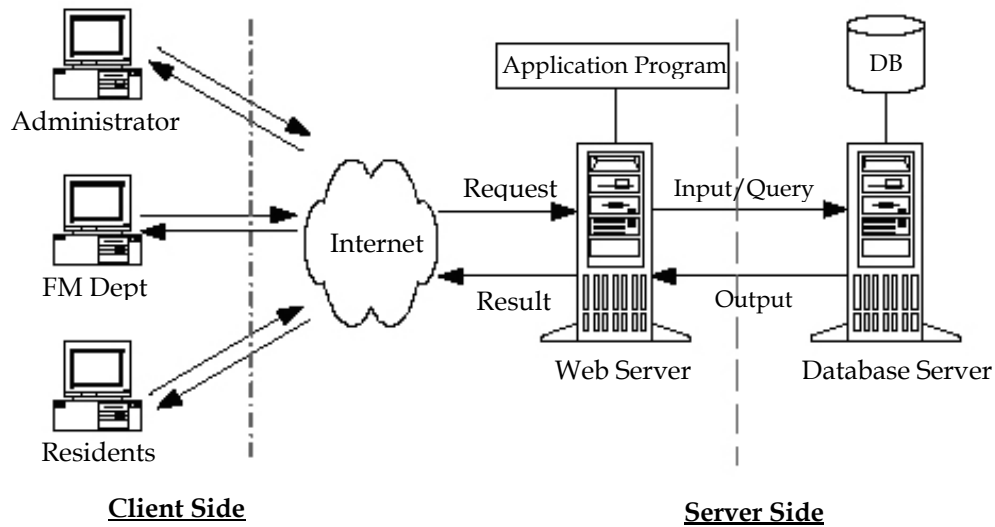


Fig. 7. System structure (Zhiliang, et al 2004)

The layer of data interpretation and the database are located on a server connected with a database connector such as ODBC. Application programs on the Web server, which consists of ASP scripts, will be executed on the database server to manipulate the data. When the users interact with the system (for example, by entering a service request in the HTML forms), the ASP scripts on the Web server will translate the input data, and pass the output data to be saved in the particular address in the database server.

In conversion, the user can also request the data from the database through the

system interface (for example, by retrieving the service request status). When the Web server gets requests, the ASP scripts translate the user's request and send the queries to the database server. After retrieving the data from the database server, it will be translated by the ASP scripts and sent back to the layer of the user interface. The scripts on the Web server can retrieve, add, update, and delete the data on the system by itself through the layer of the user interface.

Assumptions

- One unit has only one lease for a certain tenant at a particular time. Therefore, one Login ID and password are assigned for each unit, not for every resident who lives in the same place.
- A resident inserts multiple service requests in one login session. However, the resident reports problems one-by-one after every submission.
- The history of maintenance and status of service requests are fake records implemented in this research. In order to prevent confusion among the participants, the explanation is on the first login page and helps the participants understand the concept of the WGRS system.

Database Design and Implementation

The database is designed based on the relational model as first devised by Dr. E.F. Codd in 1970 to store information (Elamsri and Navathe 2000). In a relational database, items of data are stored in tables, which are logical groupings of records. This model

forms the foundation of any commercial database package, such as Microsoft Access, SQL server, Oracle and other database software (Elamsri and Navathe 2000). For the convenience of the administrator, Microsoft Access, which is included in MS office package, is used in this research.

Table 1. Various tables in the database and their functionalities

	Table name	Description
1	Table User	This table consists of information about user such as user ID, password, level, name
2	Table Employee, Table Tenant	This table consists of information about facility management staff and resident.
3	Table Report	This table consists of service request information. A unique report ID is automatically generated for every new service requested reported
4	List Location	This table consists of a list of name of the room in unit.
5	List Part	This table consists of a list of various fixture of house such as door, window, sink, toilet, etc
6	List Problem	This table consists of a list of various problems which happen in apartments.
7	Joint Location & Fixture	This table join two table, list Location and list Fixture for setting a combination of part in each room
8	Joint Fixture & Problem Type	This table join two table, list Fixture and list Problem Type for setting a combination of problem in each part

The pattern or types of requests are available through interviews with FM staff and the researcher's two years of previous experience as FM staff. The rest of the database stores user information and information related to user's requests. Table 1 explains the each table's name and contents in database system. Each table consists of rows and columns. Each horizontal column forms a record and each vertical column represents a

‘field’. Table 2 shows one of table (Joint Location & Fixture) in database system. Data from the residents is stored in the form of records.

Table 2. Fixture of each room

pbID	Fixture Name	Living Room (lcID=1)	Kitchen (lcID=2)	Bedroom (lcID=3)	Bathroom (lcID=4)
1	Sink		✓		✓
2	Toilet				✓
3	Bath Tub				✓
4	Lighting	✓	✓	✓	✓
5	Window	✓		✓	✓
6	Cupboard		✓		
7	Door	✓		✓	✓
8	Outlet	✓	✓	✓	
9	A/C & Heater	✓(Hensel APT)		✓(College View)	
10	Refrigerator		✓		
11	Range & Hood		✓		
12	Ceiling	✓	✓	✓	✓
13	Floor	✓	✓	✓	✓
14	Shelf	✓(College View)	✓(Hensel APT)		✓
15	Internet & Tel	✓(Hensel APT)		✓(College View)	

The sixty most common problems reported by residents are analyzed and categorized by the features of each fixture. Otherwise, they can be categorized as miscellanea.

- Sink – faucet leaking, leaking under sink, drain clogged up, disposer broken, overflowing, pop up broken, faucet knob broken, water pressure of faucet high or low, mold, etc.
- Toilet – water pressure of toilet low or high, water leaking from toilet, clogged up, toilet seat & lid broken, overflowing, toilet tank flapper disconnected with lever, toilet tank lever broken, toilet tank fill valve broken, mold, noise, etc
- Bathtub – water pressure low and high, faucet leaking, clogged up, pop ups broken, overflowing, shower head clogged, tub cracked, mold, etc

- Lighting – ballast noise, fluorescent starter fail, switch broken, switch plate replace, noise, smoked, etc
- Window – blind broken, blind wand broken, glass broken, frame stuck , blind stuck, fly net broken, etc
- Cupboard – cupboard broken, cupboard door hinge broken, cupboard shelf broken
- Door – door locked, door hinge broken, doorknob broken, lockset replaced, pest control, mold, etc
- Outlet – outlet plate broken, sparked, smoked, out of power, etc
- A/C & Heater – A/C high or low, Heater high or low, noise, filter replace, etc
- Range – range fan broken, range fan bulb out, range fan filter replace, gas leaking, gas range knob broken, sparked, out of power, oven broken, etc
- Ceiling & floor – cracked, mold, water leaking, etc

This defines the structure of the database system which is called Entity Relationship Diagram (ERD) (Fig. 8). Each room, fixture, and problem types is assigned a unique identification number. A combination of numbers makes one service request. HTML image map tags are assigned for specific areas and fixtures so that system recognizes combinations of numbers for the request.

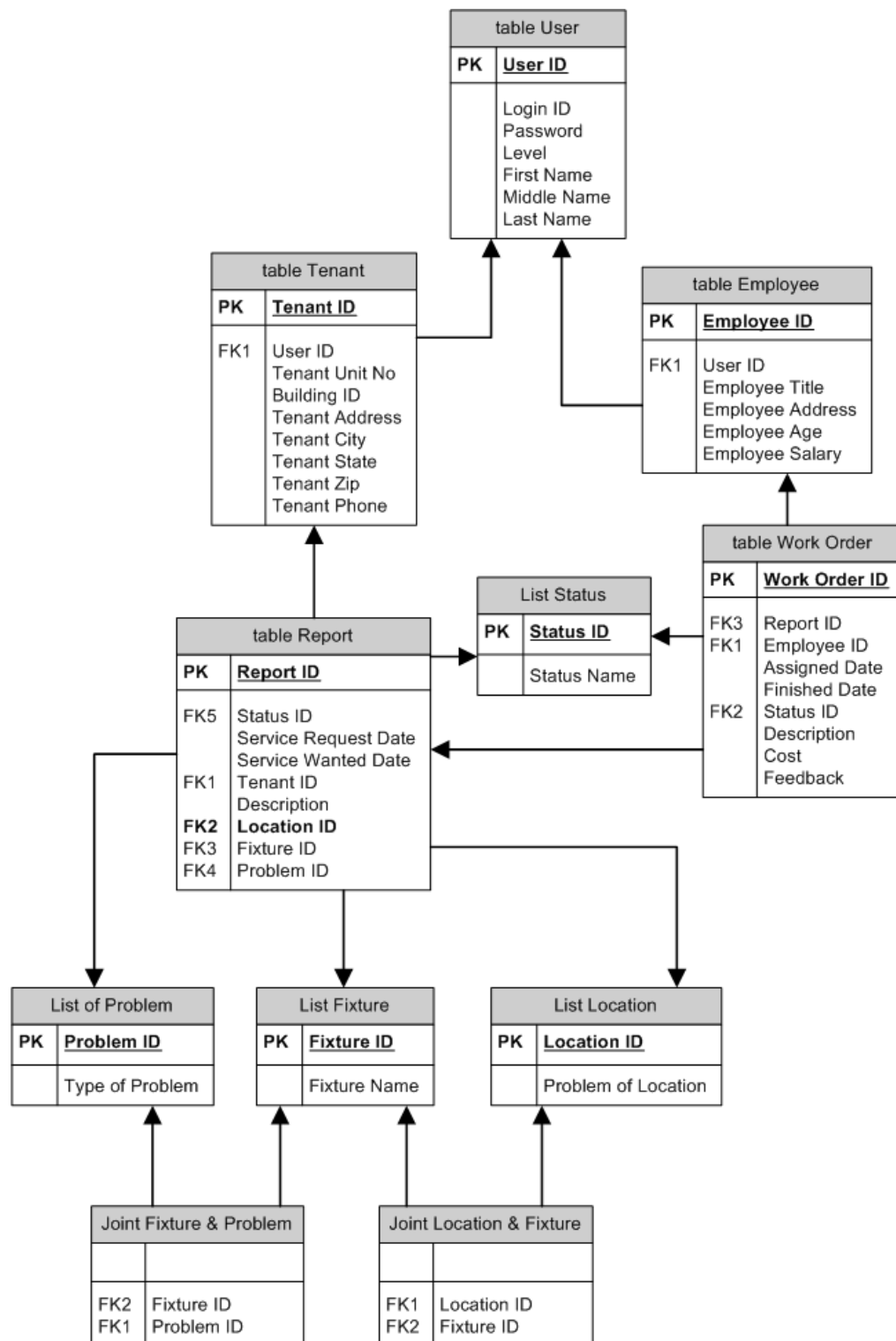


Fig. 8. Entity Relationship Diagram (ERD)

SYSTEM INSTALLATION AND USER INTERFACE

Security and Access Control

The Web-based Service Request System can be used only by logging into the system. The administrator must authorize user IDs and passwords for residents' access. Also, the user level will be assigned by the administrator for different layer access. On the main entry page of the system (Fig. 9), the user will be asked for the login name and password. When the user is authenticated, the system stores their user ID and user level in the session variable. The concept of the system access control is "one-time-access", which means that the users will be asked for the password only one time at the beginning when they access the system (Ratanamonkasem 2000). Once logged into the system, the user can use the system as long as they do not leave the system for more than twenty minutes. This time limit protects the data in case the user leaves without logging out from the system (Shar 2001). These session variables will be used in the ASP scripts to request service and retrieve each user's report information.

Information Sheet - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Search Favorites

Address Go

Graphic Service Request System For Operation & Maintenance of APT

Internet Service Request System for Operation & Maintenance of APT

INFORMATION SHEET

You have been asked to participate in a research study about Internet service request system for apartment maintenance. You were selected to be a possible participant because you live Hensel terrace or college view apartment. A total of 20 people have been asked to participate in this study. **The purpose of this study is that residents report problems of house more easily and correctly through the Internet so that facility management department delivers high quality service.**

If you agree to be in this study, you will be asked to answer the questionnaire survey after using this system. This study will only take at least 15 minutes to review the system and finish the questionnaire survey. There are no risks associated with this study at all. The participation in providing data/information will be totally voluntary. They have the full choice of not participating at all. The proposed research does not offer any compensation to subjects and participants.

This study is confidential. The records of this study will be kept private. No identifiers linking me to the study will be included in any sort of report that might be published. Cookies will not be placed on the subject's computer by accessing the survey. Research records will be stored securely and only Kwang J. Lee will have access to the records. Your decision whether of not to participate will not affect your current or future relations with Texas A&M.

If you decide to participate, you are free to refuse to answer any of the questions that may make you uncomfortable. You can withdraw at any time without your relations with the university, job, benefits, etc., being affected. If you have more questions, you may contact one of the following persons:

Principal Investigator	Advisor of Investigator
Lee, Kwang J	Valerian, Miranda
MS 3137 Department of Architecture	3137 Department of Architecture
Texas A&M University	Texas A&M University
College Station, TX 77843-3137	College Station, TX 77843-3137
(979)571-6098, architect@tamu.edu	(979)845-3033, v-miranda@archone.tamu.edu

This research study has been reviewed by the Institutional Review Board- Human Subjects in Research, Texas A&M University. For research-related problems or questions regarding subjects' rights. You can contact the Institutional Review Board through Ms. Angella M Raines, Director of Research Compliance, Office of Vice President for Research at (979) 458-4067 (araines@vpmail.tamu.edu).

You have read the above information. You have asked questions and have received answers to your satisfaction. You have been given a copy of this consent document for you records.

Please Enter Your LoginID and Password

LoginID:

Password:

Login Reset

Web Hosting by Brinkster

Done

start

pr... Pr... SO... Inf... SU... Ad... int... Mic... Ad... Internet

1:59 PM

Fig. 9. Log in page

Service Request Section

In reporting, there are three steps for submitting a request. When residents log in the system, the perspective drawing of the floor plan is retrieved from the database. Based on the login information, the database retrieves the different floor plan for where the residents live. Figs. 10 and 11 shows different floor plans of apartments.

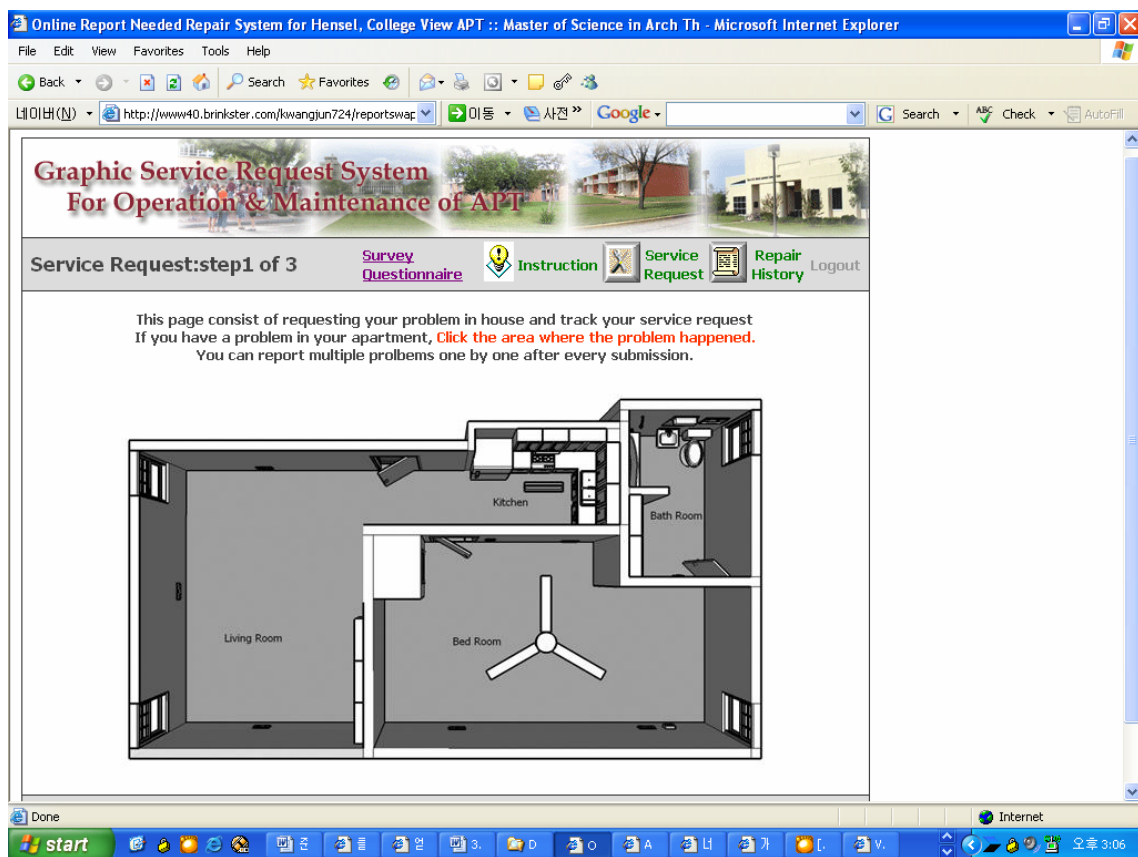


Fig. 10. First page for Hensel apartment

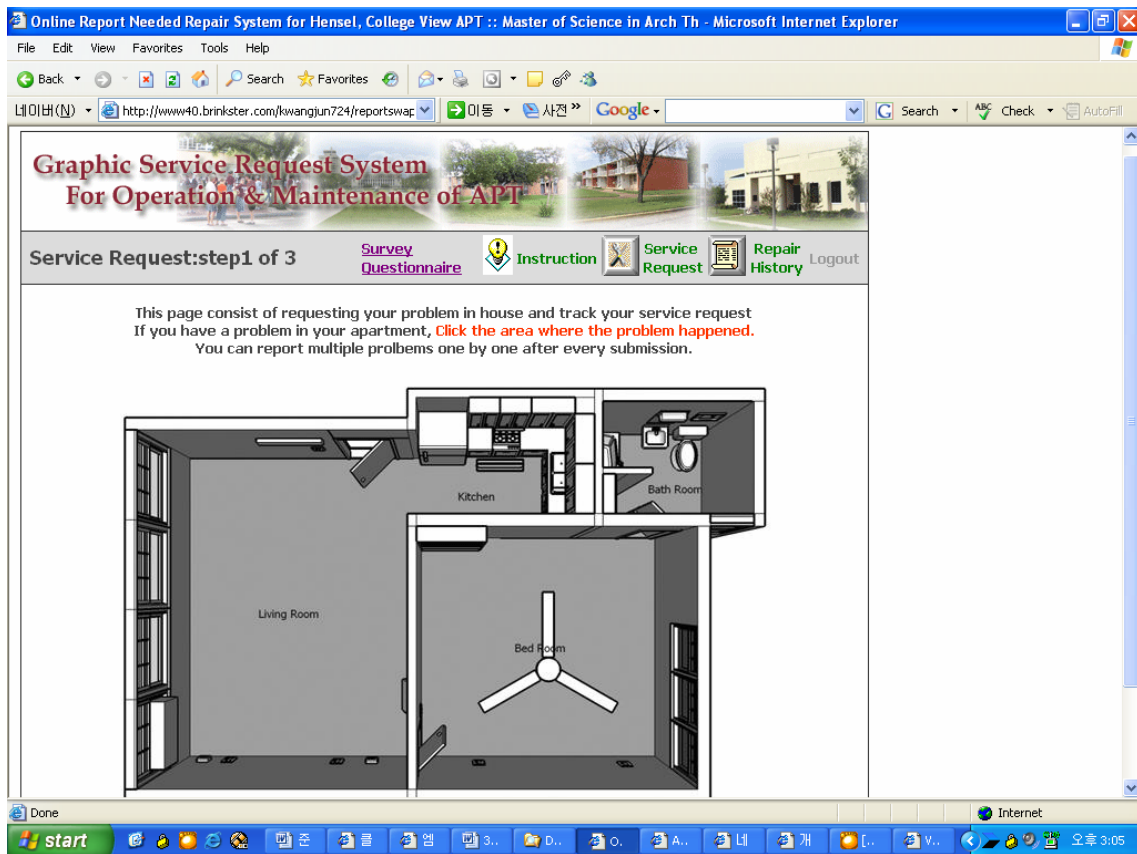


Fig. 11. First page for College View apartment

Most of the residents' apartments consist of a living room, bedroom, kitchen, and bathroom. In the first step, the resident clicks the part of the image where the problem happened. To help the user click the right area, when a mouse hovers over a specific room, the color of the room turns blue by using swap image scripts in Java (Fig. 12). For example, when there is a problem in the kitchen, the resident clicks the kitchen part on the image of the whole unit. In the second step, the resident clicks the component which has problems. Each room has common items (such as doors, windows, lighting, outlets, etc.) and unique components (such as kitchen range, sink, cupboard, toilet, bathtub, etc.).

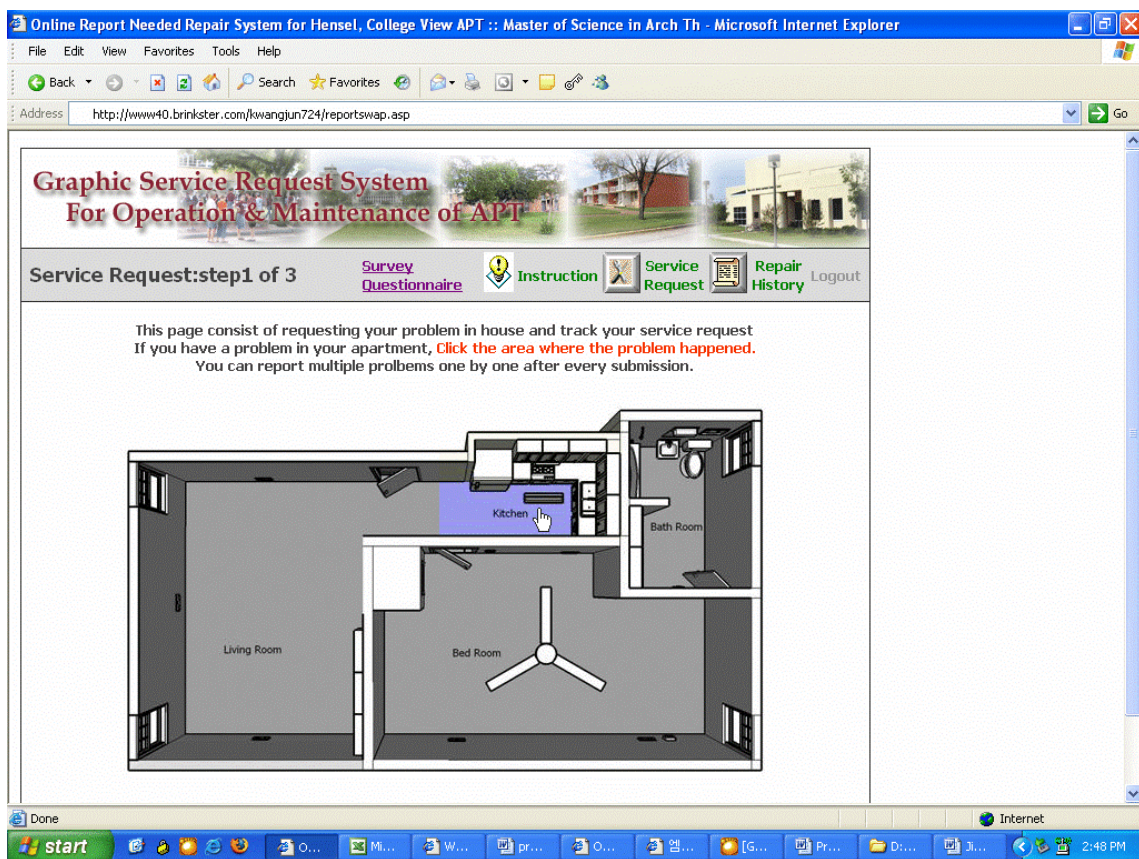


Fig. 12. Step 1 page to submit a new service request

After that, the image of the selected area magnifies in size to be the same as the previous image of the whole floor plan (Figs 13, 14, 15 and 16).

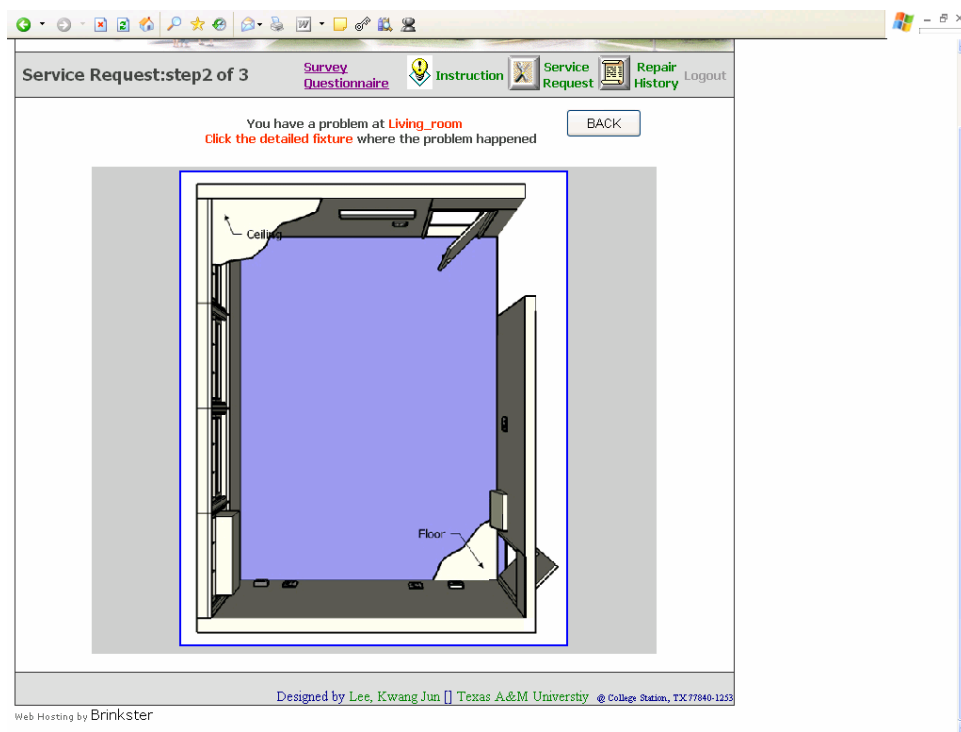


Fig. 13. Image of living room on step 2 page

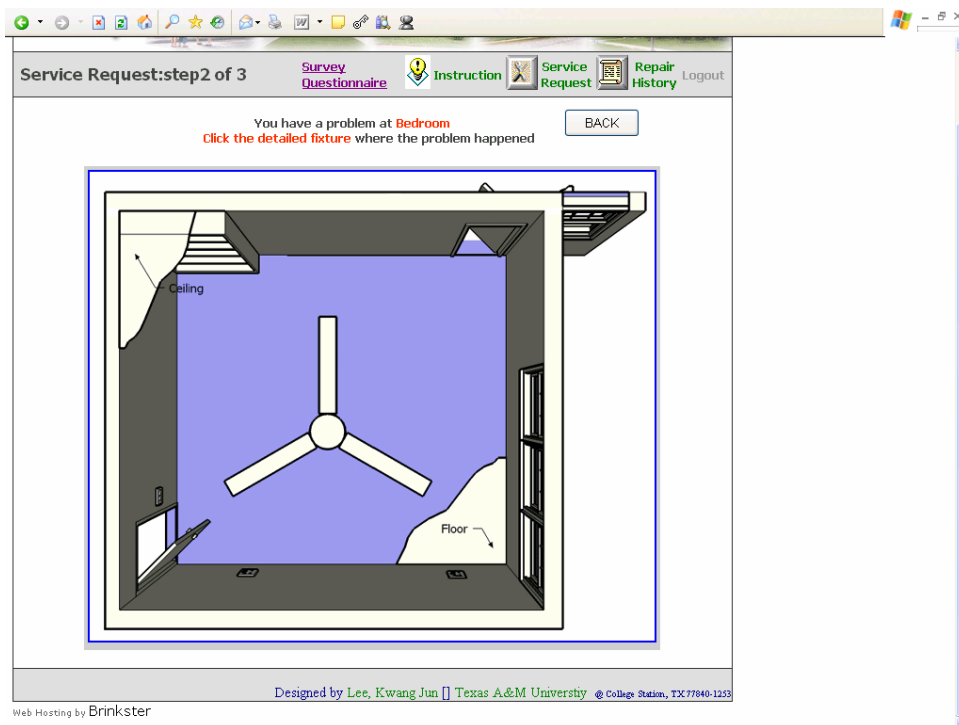


Fig. 14. Image of bed room on step 2 page

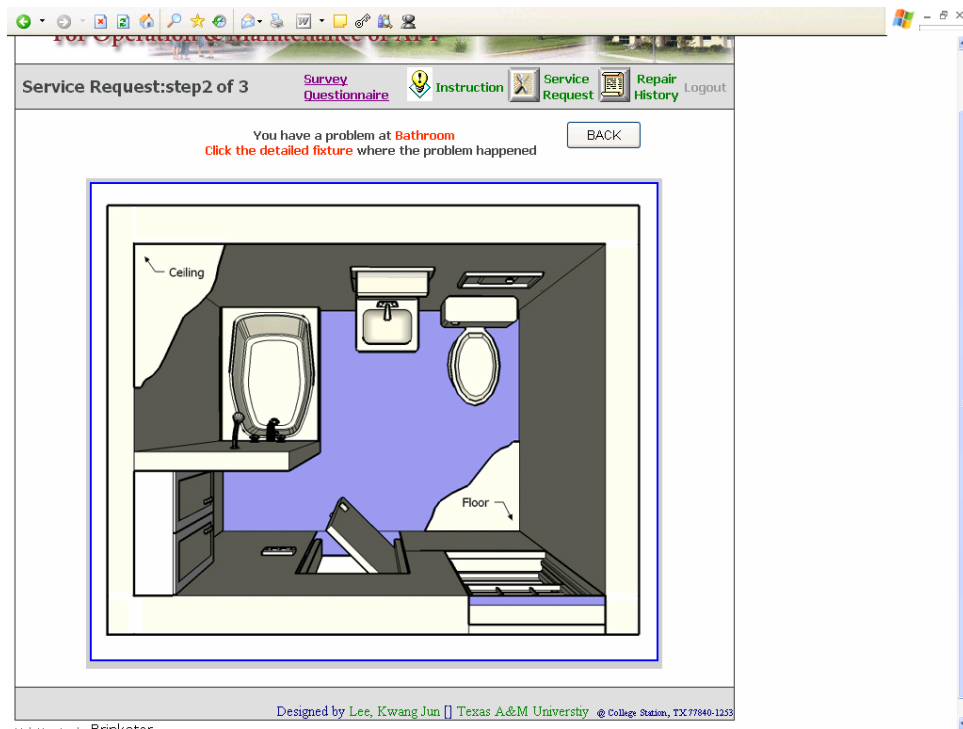


Fig. 15. Image of bathroom on step 2 page

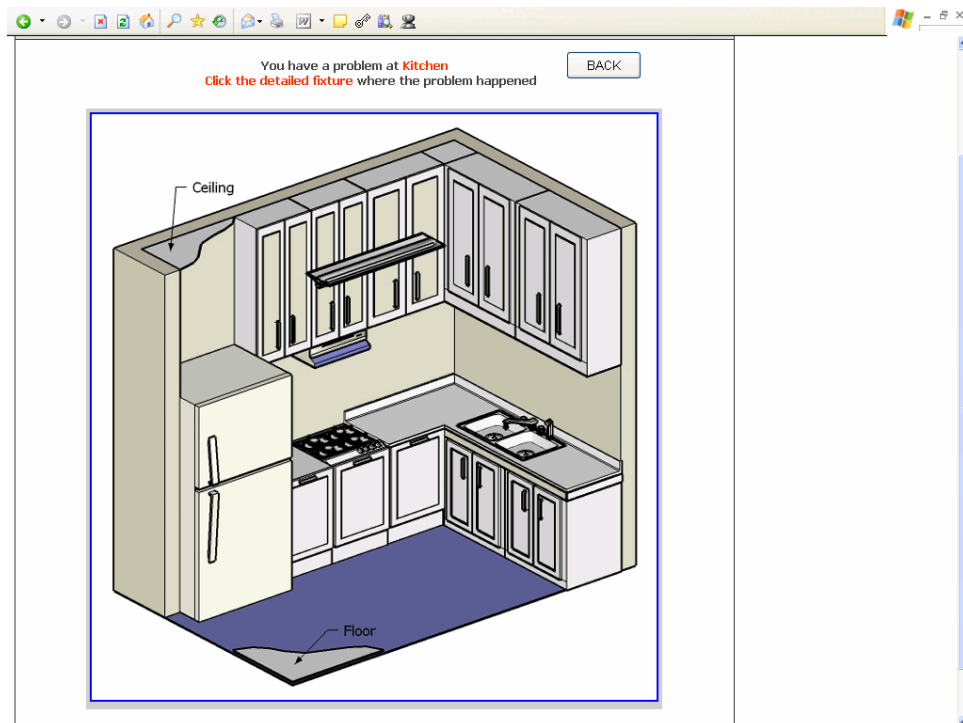


Fig. 16. Image of kitchen on step 2 page

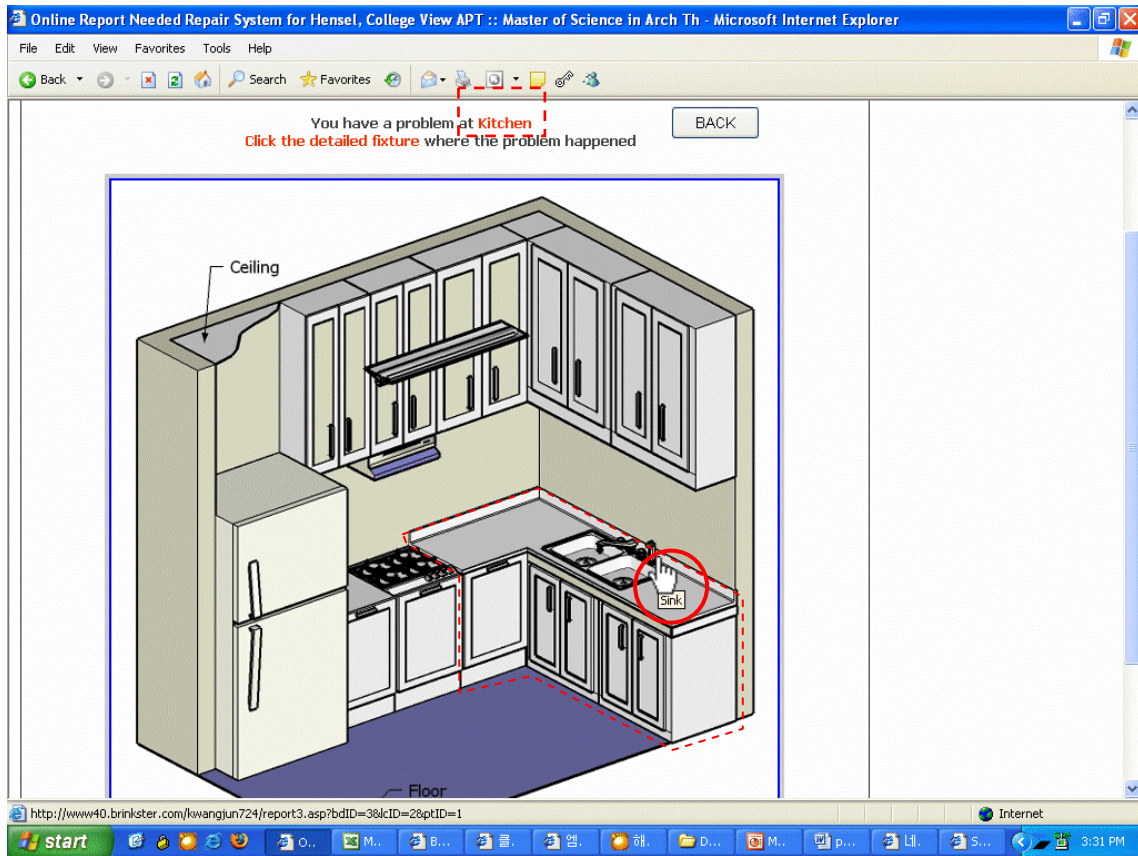


Fig. 17. Step 2 page of service request

In Fig. 17, the ASP generates a sentence for the place which resident selected. In the second step, the resident clicks on the detailed part of the fixture. When the mouse hovers over each fixture on the image, the name of component appears on the image so that the user can select the correct part.

Online Report Needed Repair System for Hensel, College View APT :: Master of Science in Arch Th - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites

Service Request: step3 of 3

Survey Questionnaire Instruction Service Request Repair History Logout

Select the date you want for service and
Select the detailed problem from drop-down menu

BACK

Unit No: 106

Service Request Date: 1/24/2006 4:45:05 PM

Service Desired Date: 01/25/2006

Location of Problem: Kitchen

Fixture of Problem: sink

Type of Problem: Select one

Description: (optional)

faucet leaking
leaking under sink
drain clogged up
diposure broken
overflowing
pop ups broken
faucet knob broken
water pressure low
pest control
noise
water pressure high
mold
others(type detail in below)

Designed by Lee, Kwang Jun Texas A&M

Web Hosting by Brinkster

start Internet 3:47 PM

Fig. 18. Step 3 of service request

In the next step, the final form of the service request appears right after the image, (Fig. 18). The location and fixture of the problem has already been chosen in the previous stage. Additionally, a red dash-dot layer will be created around the fixture of the problem to help the user recognize the area they selected. The system can do this because it recognizes the identification number of each fixture and it creates a layer for the specific fixture. For the type of problem, the ASP scripts retrieve problem types only related with the specific area and fixture selected in first and second steps. This is possible because the associated table has information on which fixture has what kinds of

problems. If the type of problem does not appear in the drop-down menu, the resident can select “other” and write down a detailed explanation about the problem in the description box. The administrator can add this problem to the database if the same kinds of problems happen frequently.

Before submitting the service request, a confirmation step appears to make sure the user reports the exact problem correctly (Fig. 19). The user can submit multiple problems one by one after every submission. Fig. 20 shows the end of one service request.

Online Report Needed Repair System for Hensel, College View APT :: Master of Science in Arch Th - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Go

Address http://www40.brinkster.com/kwangjun724/report_confirm1.asp?tnID=7&UnitNo=106&time=1%2F25%2F2006+4%3A26%3A59+PM& rptSWDate=01%2F26%2F2006&lcName=Kitcd

Service Request Confirmation Survey Questionnaire Instruction Service Request Repair History Logout

This page shows your service before reporting please confirm unless there is wrong choice

BACK

Unit No: 106

Service Request Date: 1/25/2006 4:26:59 PM

Service Desired Date: 01/26/2006

Location of Problem: Kitchen

Fixture of Problem: sink

Type of Problem: drain clogged up

Description:

submit Back To Main page

Designed by Lee, Kwang Jun | Texas A&M University @ College Station, TX 77840-1253

Fig. 19. Service request confirmation page

Online Report Needed Repair System for Hensel, College View APT :: Master of Science in Arch Th - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Search Favorites

Address <http://www40.brinkster.com/kwangjun724/reported.asp> Go

Graphic Service Request System For Operation & Maintenance of APT

Service Request Reported [Survey Questionnaire](#) [Instruction](#) [Service Request](#) [Repair History](#) [Logout](#)

Your service request has been reported as below

Unit No	Request No	Request Date	Wanted Date	Status	Problem Location	Problem Part	Problem Type
106	127	1/25/2006	1/26/2006	reported	Kitchen	sink	drain clogged up

[Go To Survey](#) [Report another problem](#)

Designed by Lee, Kwang Jun [] Texas A&M Universtiy @ College Station, TX 77840-1253

Web Hosting by Brinkster

start Internet

3:27 PM

Fig. 20. The resident's graphic input produces a text-based problem on the fly

The Layer of Feedback for Communication with Interface

To facilitate the layer of feedback in the interface design specifications, Java scripts have been used in every section. If the user miss-typed the Login ID or password in the login section, the alert box pops up to notify the user (Fig. 21).

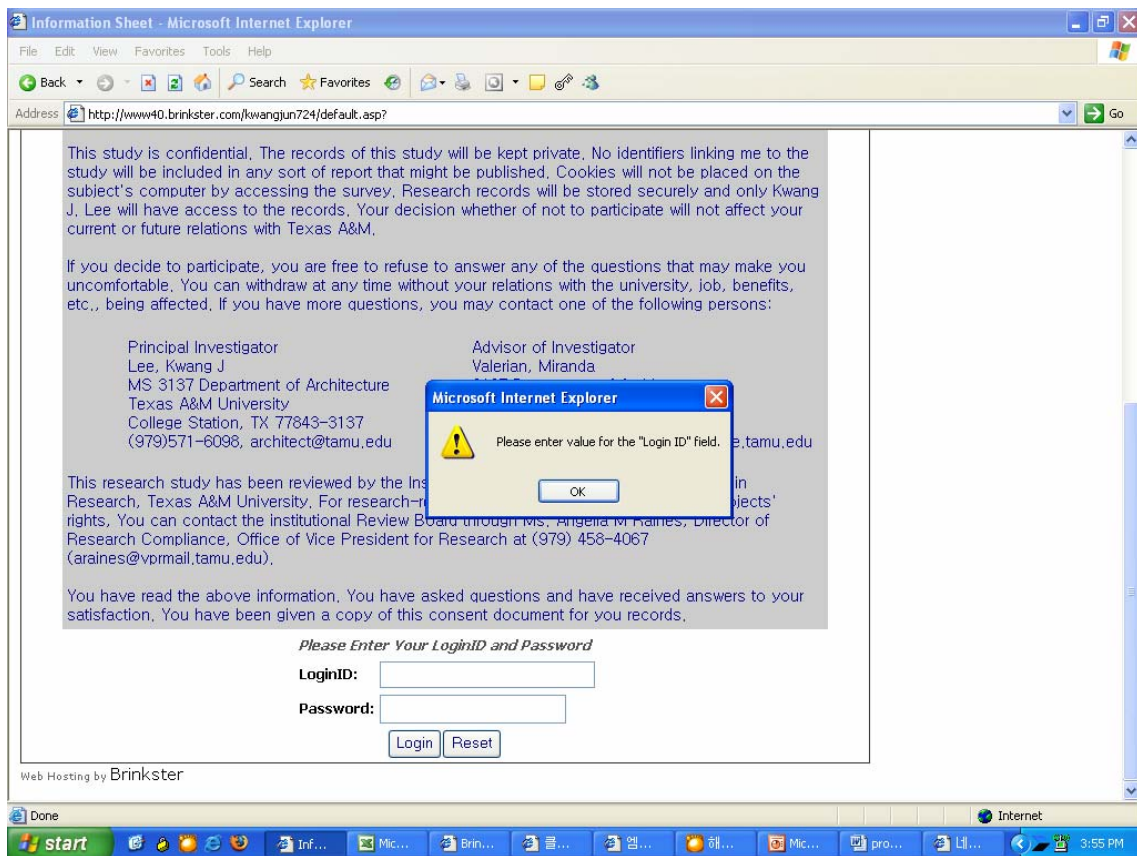


Fig. 21. Alert box for login information

Fig. 22 shows the calendar appearing on the service request section. This calendar helps users input the right format for the date from the pop-up window by clicking on the calendar icon.

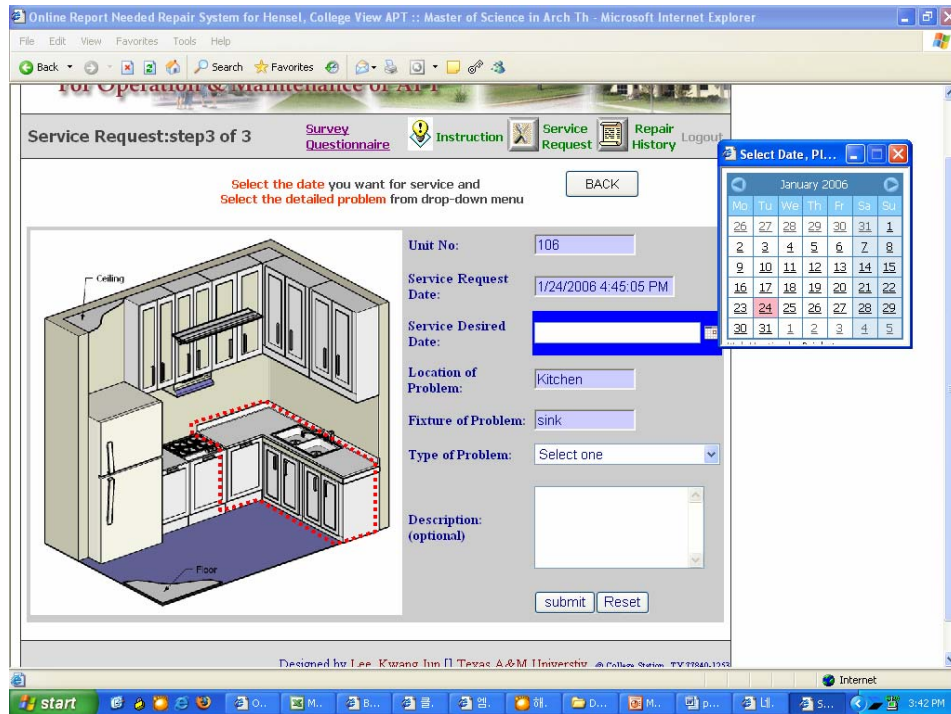


Fig. 22. Calendar pop up box for residents helps them select the right date

For selecting service desired date from pop up calendar, the user can not select the past date. In this case, alert box pop up to notify the user select later date (Fig. 23).

Moreover, from midnight to noon the user can request the same day request. However, after noon to midnight the user can not select the same date for service request.

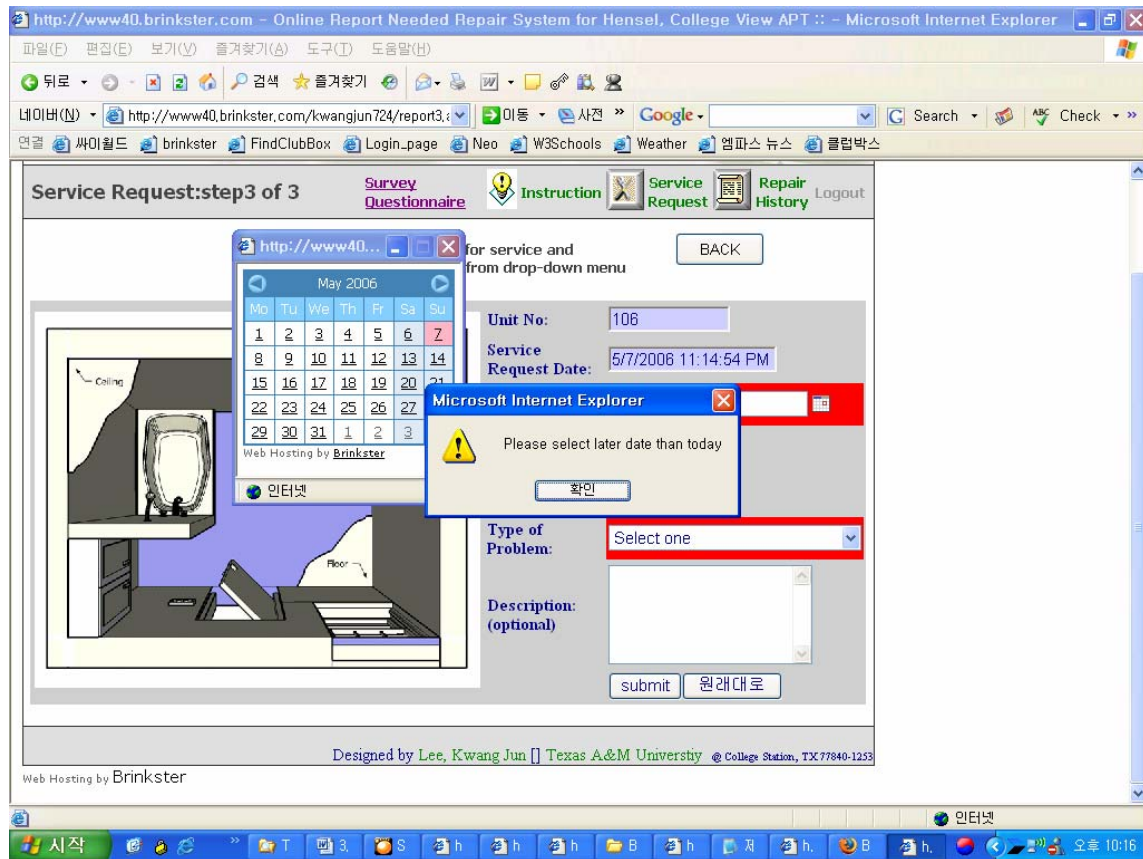


Fig. 23. Alert box for selecting the past date

If the user selects the same date for service request from 12:00 to 17:00, alert box show “It’s too late for today request. Select later date than today.” After 17:00, the alert box show “Office hours is over. Select later date than today.” (Fig. 24).

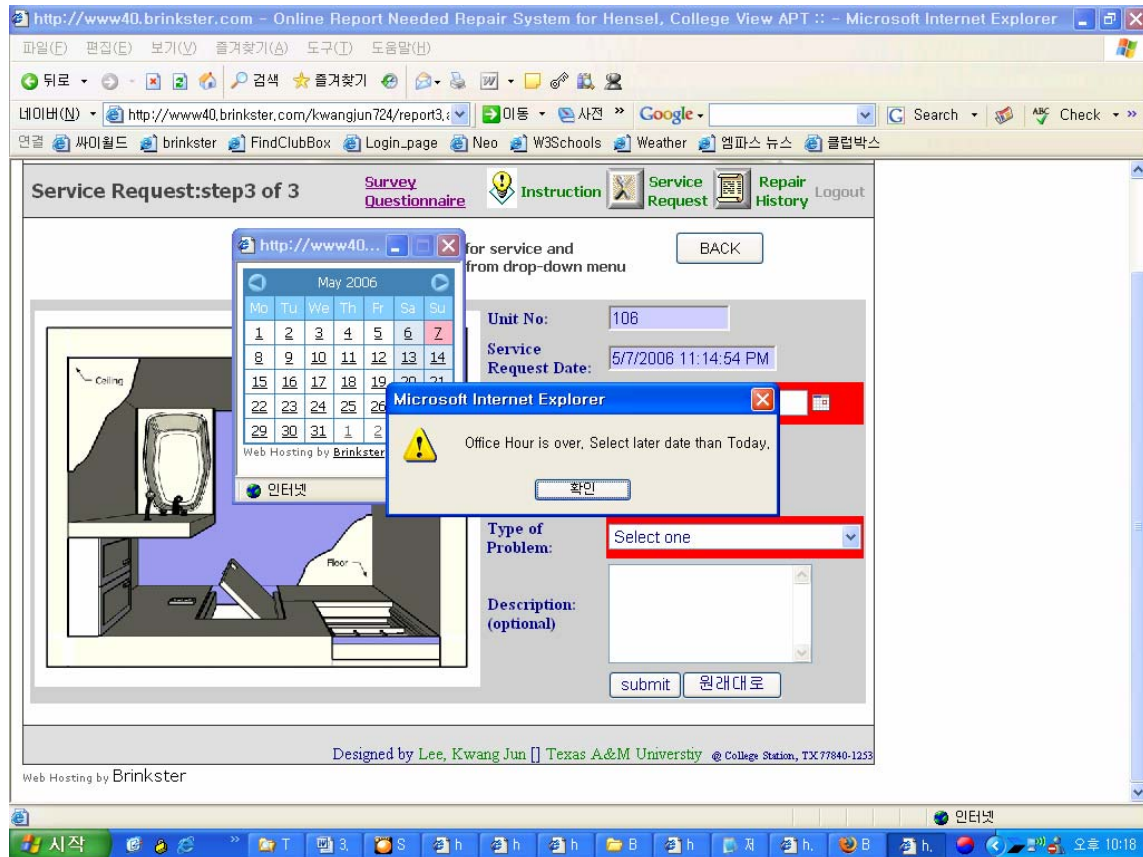


Fig. 24. Alert box for selecting the same date after office hour

Online Report Needed Repair System for Hensel, College View APT :: Master of Science in Arch Th - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Address http://www40.brinkster.com/kwangjun724/report3.asp?bdID=3&ctID=1&ptID=10

Select the date you want for service and
Select the detailed problem from drop-down menu

BACK

Unit No: 106

Service Request Date: 1/24/2006 5:25:18 PM

Service Desired Date: [Blank Box]

Location of Problem: Living_room

Fixture of Problem: outlet

Type of Problem: Select one

Description (optional): [Blank Text Area]

submit Reset

Done

start

Internet

4:22 PM

Fig. 25. Style scripts for blank box

In the step 3 stage, the user has to pick a date for the repair, the type of problem, and where the problem happened. When the mouse hovers over a blank box, the column turns blue. If a mouse bypasses that box, the column around the box turns red for the user to notice the box and to alert them to fill it in (Fig. 25). If the user submits information without filling in a box, a Java scripts pop up appears (Fig. 26).

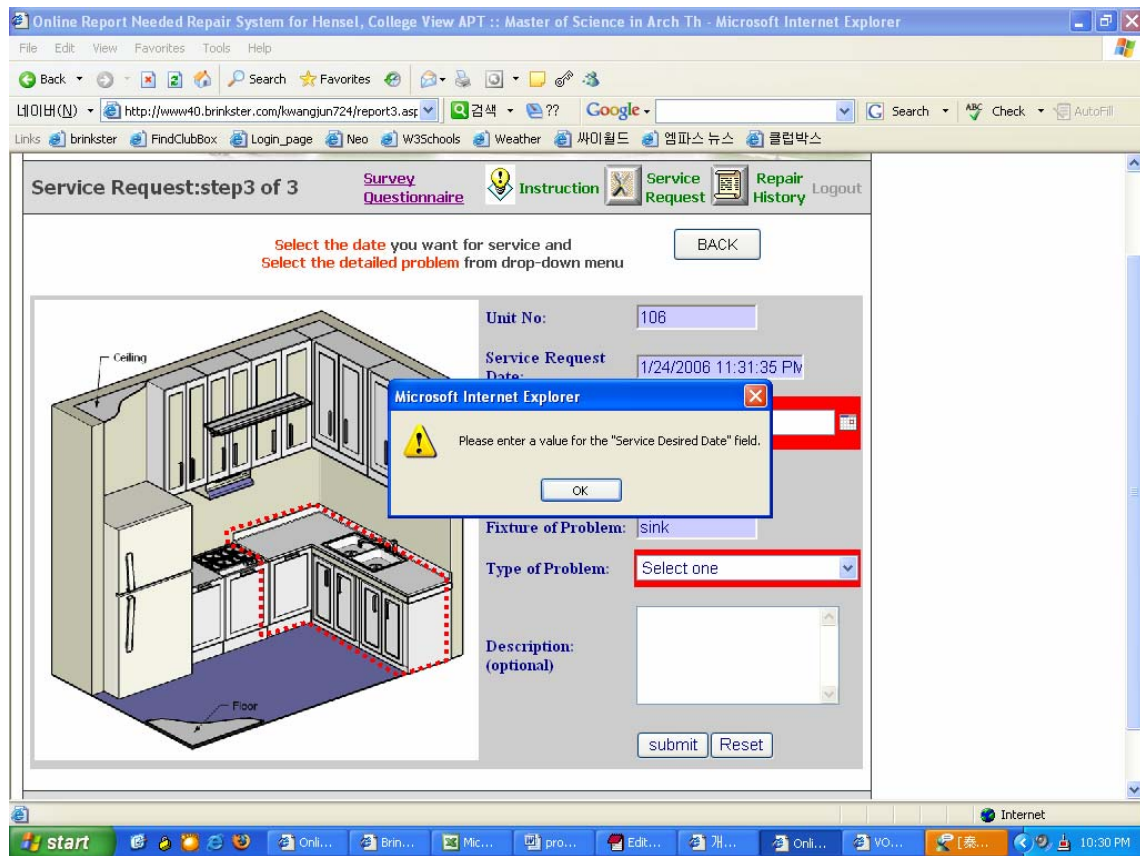


Fig. 26. Alert box for service desired date and type of problem information

Retrieve Maintenance History and Status Section

The user can check the status of a service request to see the level of its progress (Fig. 27). Staff members are often unable to repair a problem fully on the first visit; they might need to order material which is out of stock, or have to call an outside contractor for professional assistance. When residents were not at home with the maintenance staff, they can't know why the staff could not fix the problem or when they will revisit to fix the problem.

Online Report Needed Repair System for Hensel, College View APT :: Master of Science in Arch Th - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Search Favorites

네이버(N) http://www40.brinkster.com/kwangjun724/retrieve_hi 이동 사전 Google Search ABC Check AutoFill

Links brinkster FindClubBox Login_page Neo W3schools Weather 엠파스 뉴스 싸이월드 클럽박스

Graphic Service Request System For Operation & Maintenance of APT

Maintenance History and Status [Survey Questionnaire](#) [Instruction](#) [Service Request](#) [Repair History](#) [Logout](#)

This page shows the history of maintenance in your home and show the status of your service request

Unit No	Request No	Request Date	Desired Date	Status	Problem Location	Problem Part	Problem Type
212	121	1/23/2006	1/23/2006	reported	Bedroom	A/C & Heater	noise
212	120	1/23/2006	1/23/2006	on_schedule	Living room	ceiling	others(type detail in below)
212	119	1/23/2006	1/23/2006	pending	Bathroom	floor	others(type detail in below)
212	118	1/23/2006	1/23/2006	denied	Bathroom	ceiling	others(type detail in below)
212	117	1/23/2006	1/23/2006	complete	Kitchen	sink	diposure broken
212	116	1/23/2006	1/25/2006	accepted	Living room	window	blind broken

Designed by Lee Kwang Jun Texas A&M University @ College Station, TX 77843-1343

Done Internet

start 3:40

Fig. 27. Screen capture of maintenance history and status page

SYSTEM USABILITY AND DATA ANALYSIS

A pilot test was conducted to test the effectiveness and usefulness of the Web-based Graphic Service Request System. Residents were given the Web-page address through email and asked to use it for service requests, to view a history of maintenance, and the status of service requests. The system was also evaluated for issues concerning the necessity of such a tool in FM administration, the system's interaction with users, and the resident's perception and expectation for the delivery of high quality service

The Subjects

The subjects were residents of Graduate and Family living at Texas A&M University. The study population was restricted to only residents of College View and Hensel apartment complexes. Ten residents each in both College View and Hensel apartment complexes were contacted. These residents used the system for approximately fourteen days. A user account was created with the address of each resident. They were instructed to act as if there were problems in their unit (or to remember when they had problems before). They were to log in the Web-page and submit one or multiple service requests. After using the Internet service request system, they were to evaluate the usefulness of the Web-page through a Web survey. Nineteen members of the population submitted sample service requests and seventeen residents participated in the survey questionnaire.

The Survey Questionnaire

The purpose of the survey was to collect the resident's evaluation and opinion of the Web-based Graphic Service Request system. The questions asked in the Web survey form were divided into the following categories:

- WGSR: Concept and Interface
- WGSR: Usability
- Open Comments: Blank space for the residents in the survey form to fill in comments about the overall design of the system.

Result of Survey Questionnaire

Fig. 28 through Fig. 43 represent the data collected from the Web survey. Results from are summarized in Table 3.

Table 3. The result of survey

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Did not Answer
WGSR system was easy to understand	13	4	0	0	0	0
WGSR system was easy to navigate	11	5	1	0	0	0
The visual interface of WGRS system was appealing	8	8	0	1	0	0
WGSR was very easy to learn	11	5	1	0	0	0
Form button are labeled meaningfully	9	7	1	0	0	0
Overall experience of graphics on WGRS system was good	11	5	1	0	0	0
WGRS require a lot of effort to request service	3	2	2	4	6	0
History and status of your service requests of WGRS were satisfactory	4	9	4	0	0	0
Have you ever had previous experience with similar Internet reporting page?	5	0	0	0	11	1

1. Concept and Interface

- **Comprehensibility** – The Graphic-based Service Request system and the information were developed in a manner that is easy to learn and understand and which makes the system comprehensible for various actions. In the comprehensibility review, thirteen out of seventeen participants strongly agreed and four out of seventeen participants agreed that the system is easy to understand.

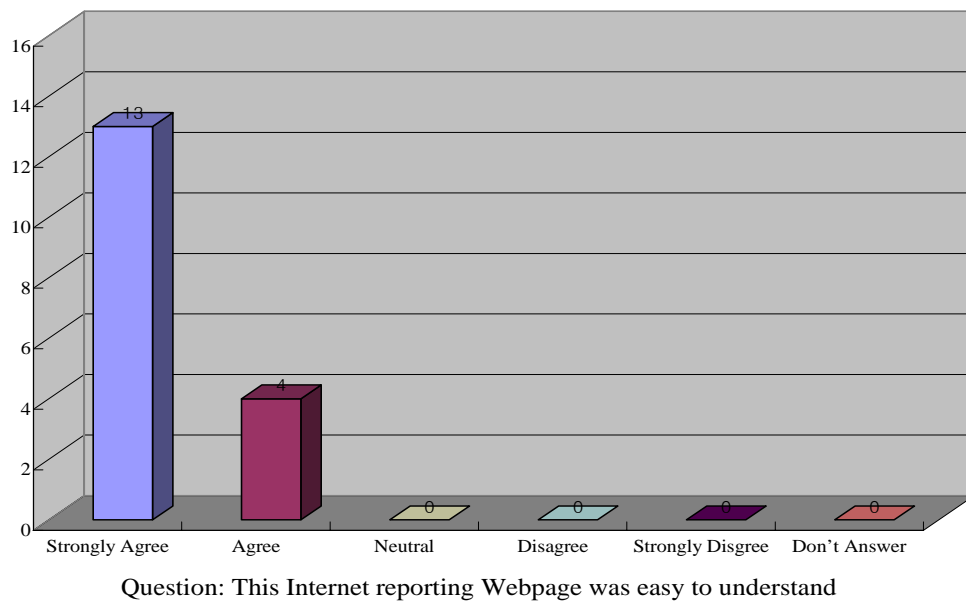


Fig. 28. Results from the comprehensibility question

In the learn-ability review, eleven out of all participants strongly agreed and six out of all participants agreed that the system is very easy to learn.

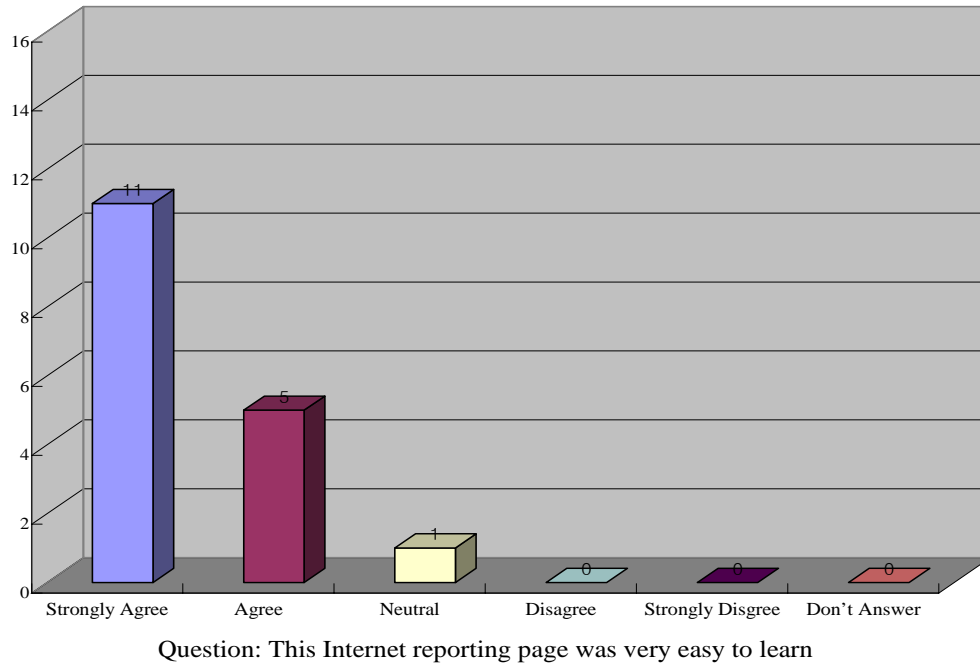


Fig. 29. Results from the learn-ability question

- Aesthetically pleasing – Eight out of seventeen participants strongly agreed and eight out of all participants agreed that the system was visually appealing. Swapping images in step 1 provided a meaningful contrast and the use of color effectively made the interface of WGRS system a visually pleasing means of reporting problems. Perspective and isometric drawings helped users recognize each room and fixture.

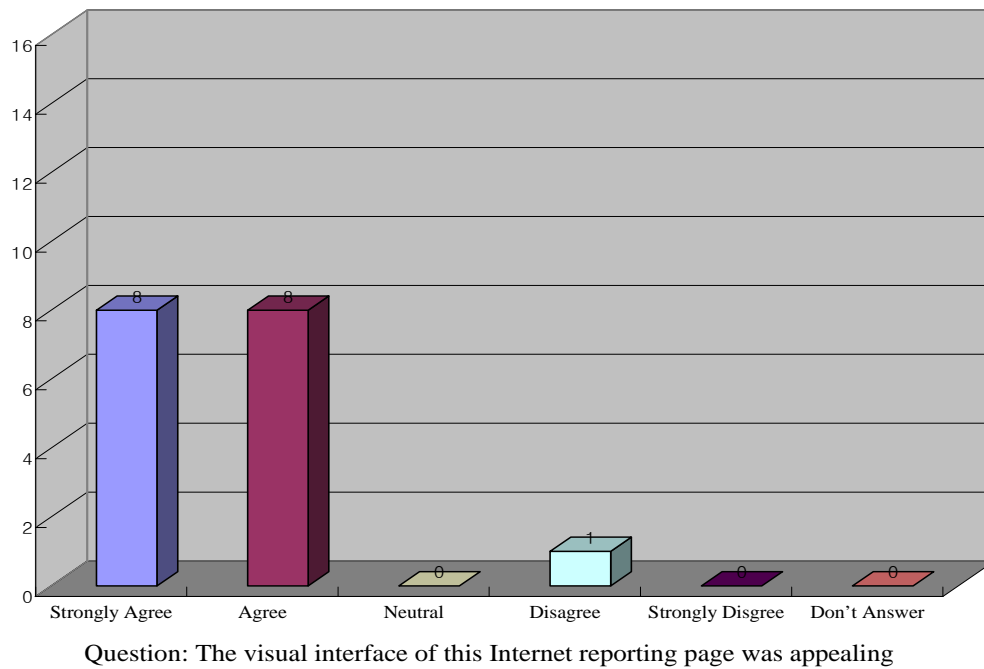


Fig. 30. Results from the user interface question

- Clarity – Eleven out of seventeen participants strongly agreed and five out of all participants agreed that the system was easy to navigate. In the label issue, nine out of participants strongly agreed and seven out of participants agreed that the form buttons were labeled meaningfully. The interface was visually, conceptually, and linguistically clear as almost all the users were able to follow the text very easily and the navigational controls without help from the researcher.

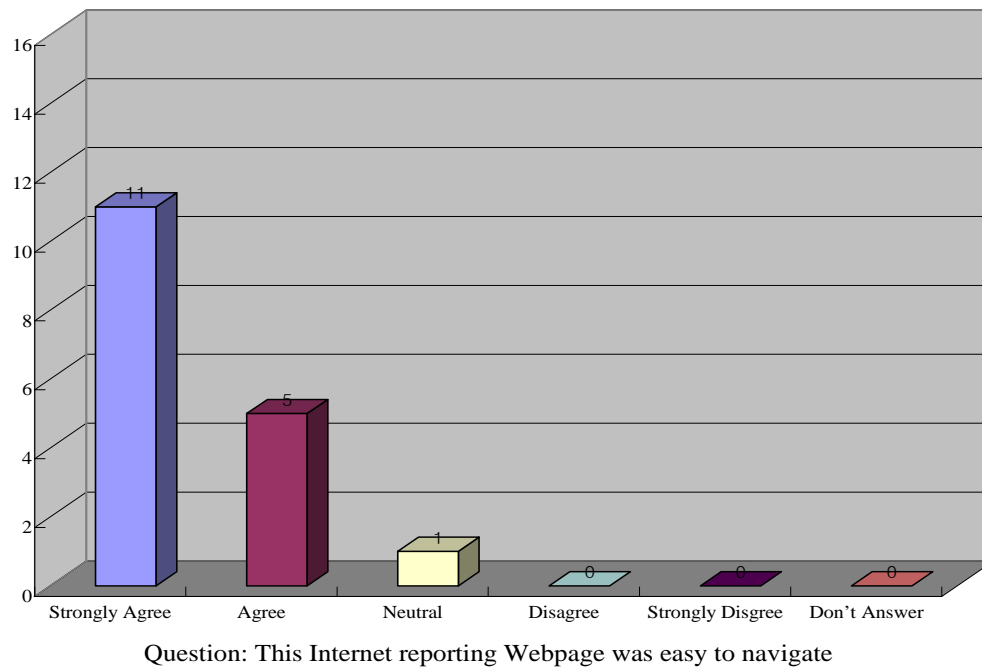


Fig. 31. Results from the navigability question

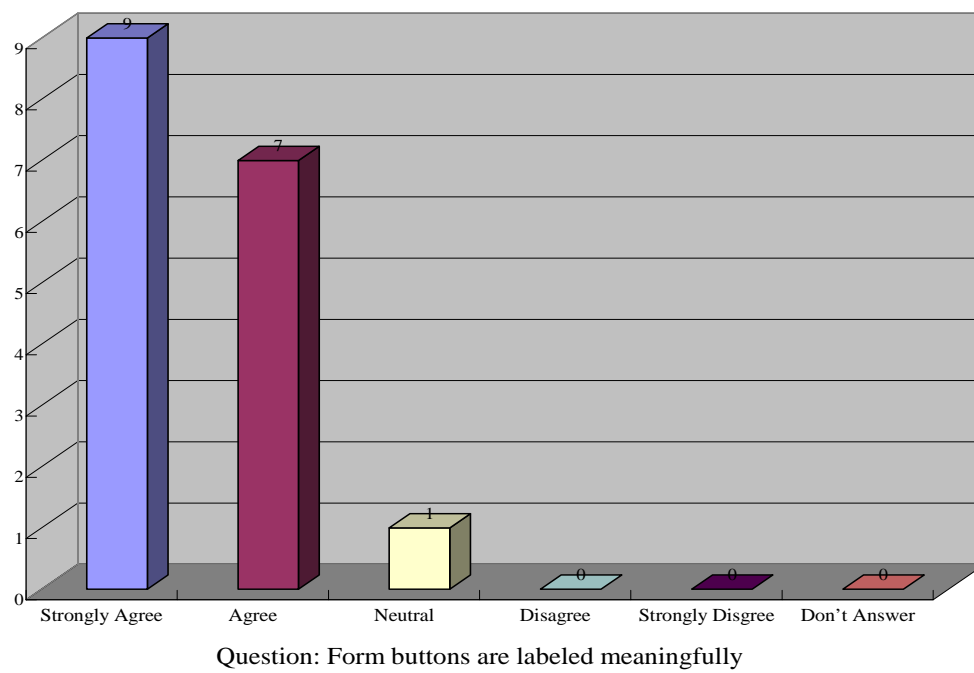


Fig. 32. Results from the label and titles question

- **Simplicity** – Three out of eleven participants strongly agreed and two of them agreed that the system required a lot of effort to request service. However, these five people answered that the system was easy to use, navigate, and learn in the comprehensibility, navigability, and learn-ability reviews. Moreover, two participants who strongly agreed that the system needed a lot of effort said that they would like to continue using the system and that the system was really easy and convenient to use. Although their answers are somewhat contradictory, the open comment answer is a more reliable measure than the check box answer because it explains their perception linguistically. Therefore, the two answers could be analyzed to conclude that the system is simple.

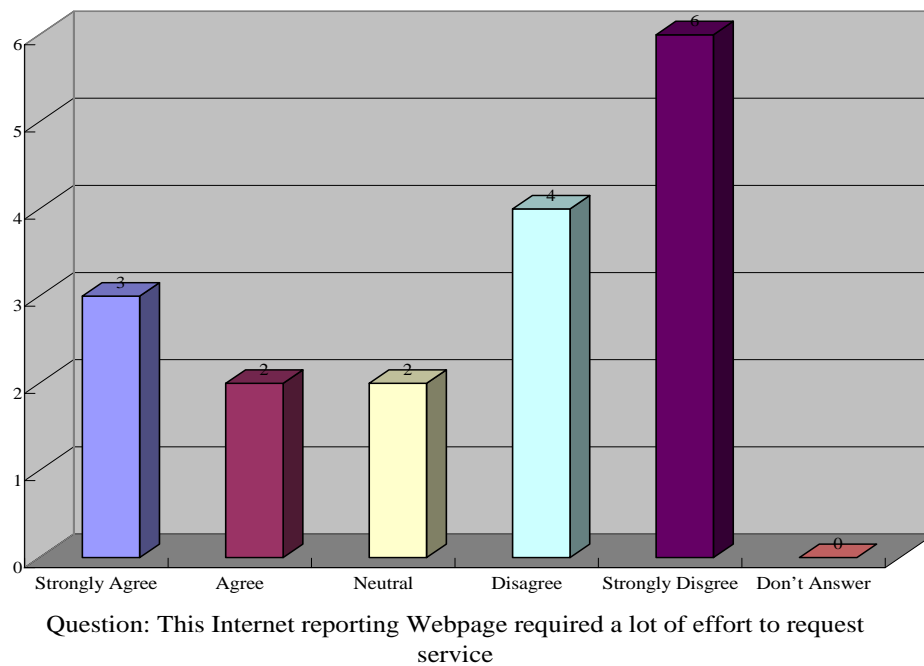
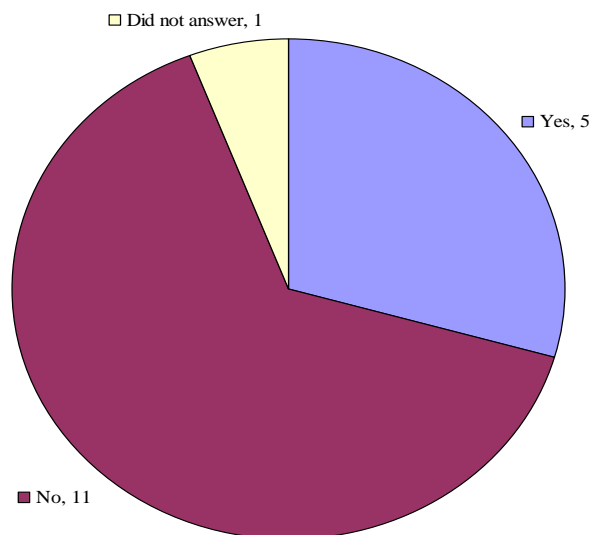


Fig. 33. Results from the question about ease of the system

- **Compatibility** – The graphic user interface of this system is the key feature compared to existing systems. Five out of seventeen participants have experienced similar Internet reporting pages and the rest of them have not. Nevertheless, all of them said that overall experience of the graphics on the system was good. The intended user of a new system is often the user of other systems or earlier version of the new system. While compatibility across products must always be considered in relation to improving interfaces, making new systems compatible with existing systems will take advantage of what users already know, and reduce the necessity for new learning (Galitz 2002). Four out of seventeen participants strongly agreed and nine out of seventeen agreed that the history and status of the maintenance record page was satisfactory.



Question: Have you ever had previous experienced with similar Internet reporting page?

Fig. 34. Results from the prior experience question

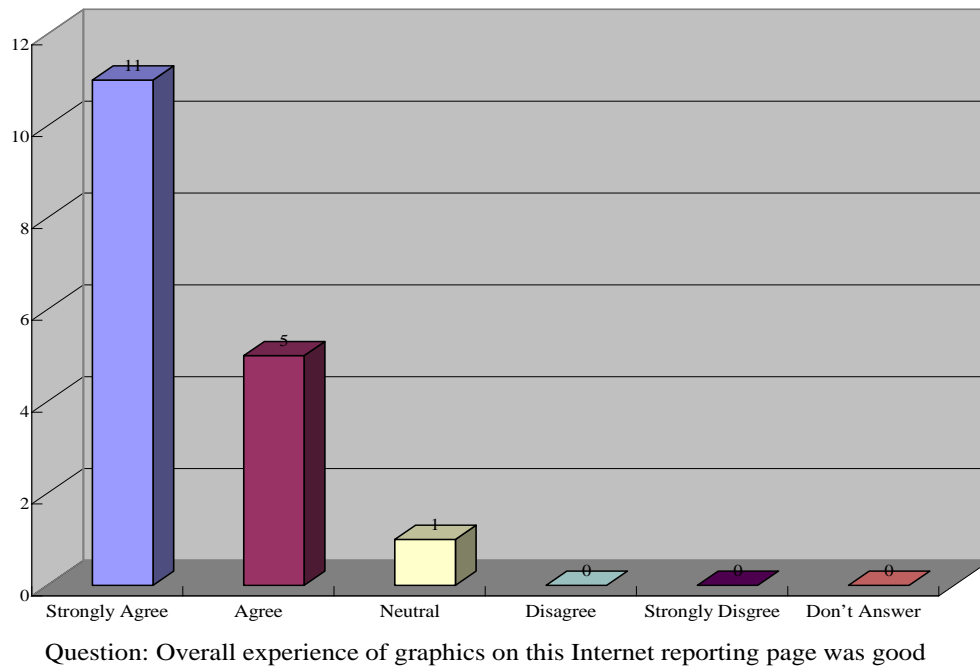


Fig. 35. Results from the graphically appealing question

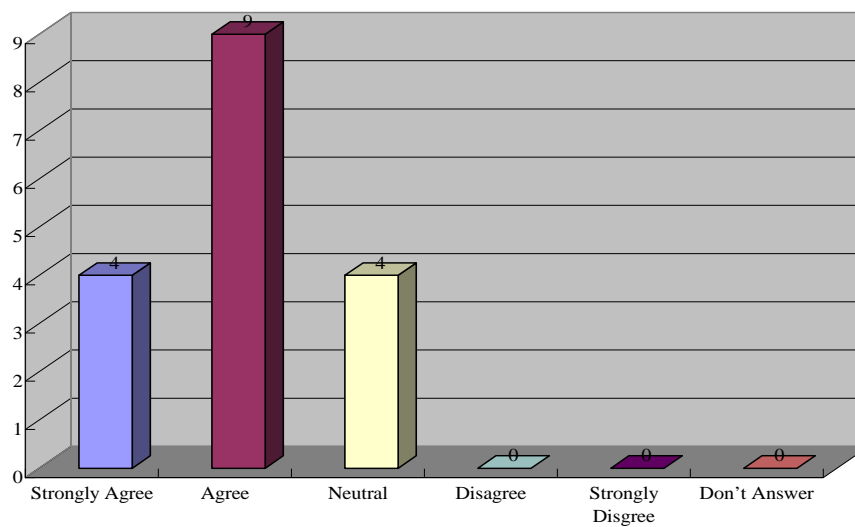


Fig. 36. Satisfaction of history and status of maintenance page

2. Usability

In the second section of the questionnaire, residents were asked how they communicate with the FM organization and what communication problems they experience. The answers of the participants helped the researcher support the feasibility of the WGSR system.

- Communication – Thirteen out of seventeen participants reported their problems by telephone and two of them requested services face-to-face by walking in to the FM office. Nine out of seventeen participants encountered problems in communication with the lease office.

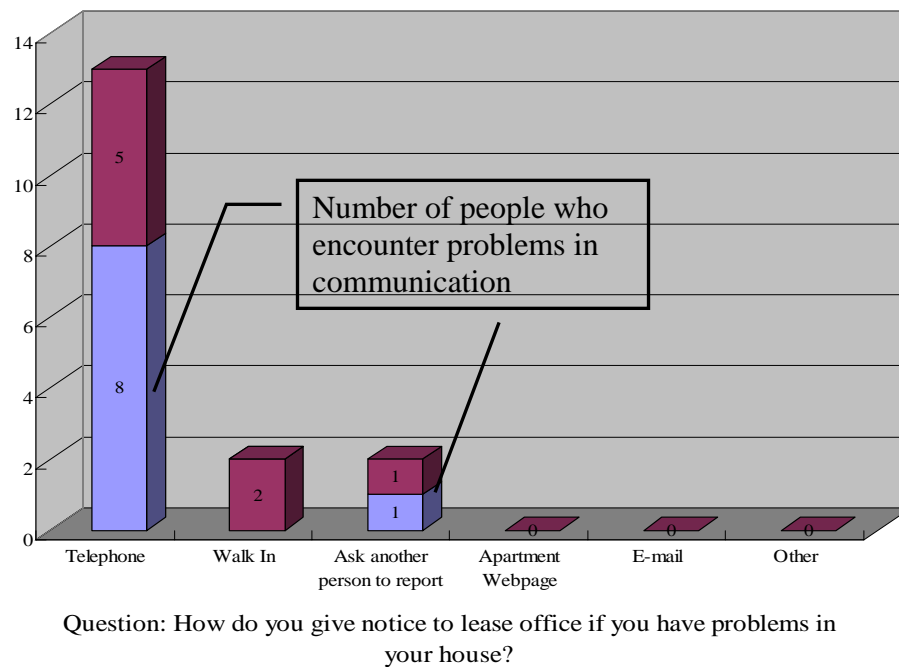
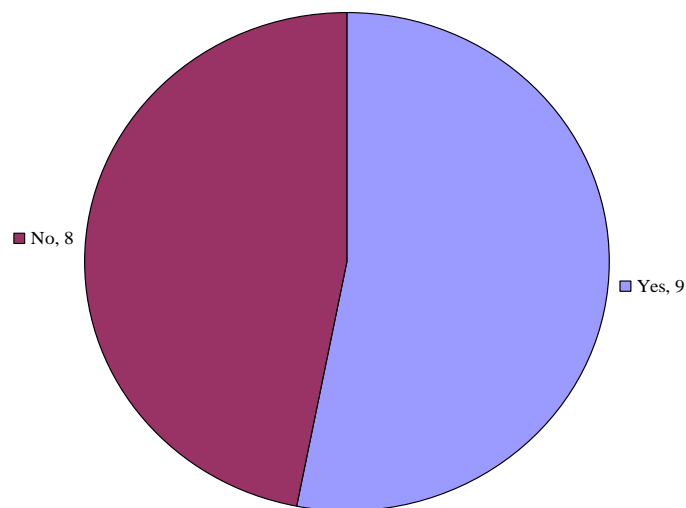


Fig. 37. The way of communication with FM administration

Eight out of nine people another person to make the report. Therefore, it is concluded that reported their problem by telephone, and the remaining individual asked communication problems still exist between residents and the FM office.

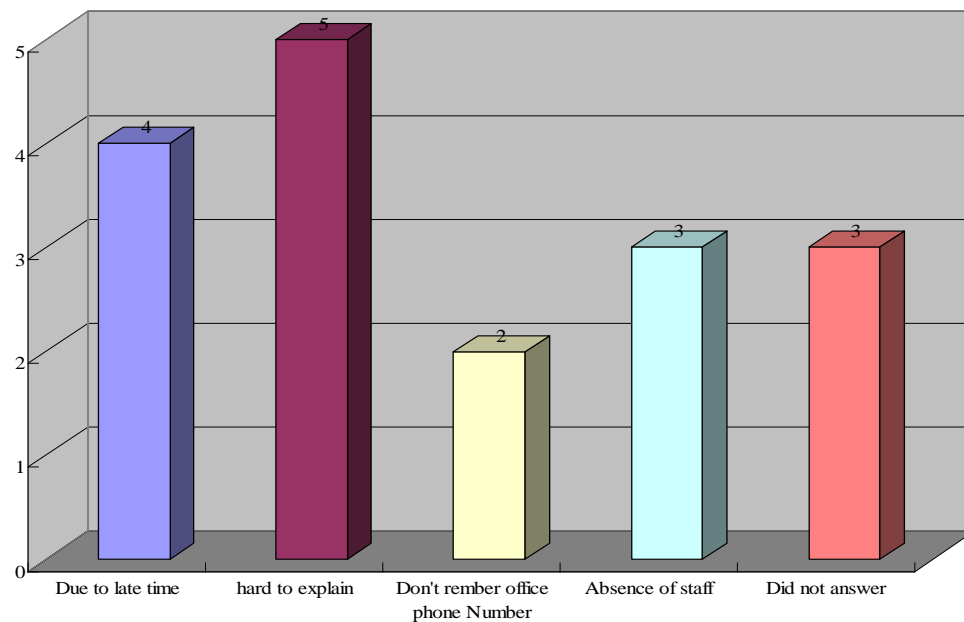
- **Hesitation** – Hesitation is the unwillingness to do something, or a delay in doing it, because of uncertainty, worries, or embarrassment. If a customer feels hesitation before asking for service, it is even harder to deliver high a quality service and satisfy the customer. In service requests, five out of seventeen participants said they felt it was hard to explain the problem, and four of them hesitated to report it due to time limitations. Three of the participants hesitated to report problems due to the absence of staff supposed to receive phone calls, and two of them hesitated because they did not remember the office phone number. For the issue of difficulty explaining the problem, the WGRS system supports a graphic service request interface and which addresses the shortage of oral requests. For issues related to time limitations and the absence of staff, the Internet page supports 24/7 submission which enables the user report anytime from anywhere. Moreover, the customer does not need to worry about the absence of staff because the WGRS system records the request right into the database. In open comment area of section 3, two people suggested that the system include an alternate contact method for the maintenance office, such as a phone number or email, which are not presently in the system; because this research tested the

concept of a graphic service request, the alternate contact information was deliberately not included. For the real application of the service, other contact information should be given for the system, for use in an emergency for example.



Question: Have you ever hesitated to report any problems you have?

Fig. 38. The rate of hesitation of reporting



Question: If yes, what is the reason for hesitating?

Fig. 39. The reason of hesitation to report

- Recognition - If the FM staff does not recognize the problem correctly in the first place, they are unable to prepare and bring the material needed to fix it. Re-visitation for the same reason also bothers residents. Service should be delivered correctly the first time in order to satisfy the customer as quickly as possible.

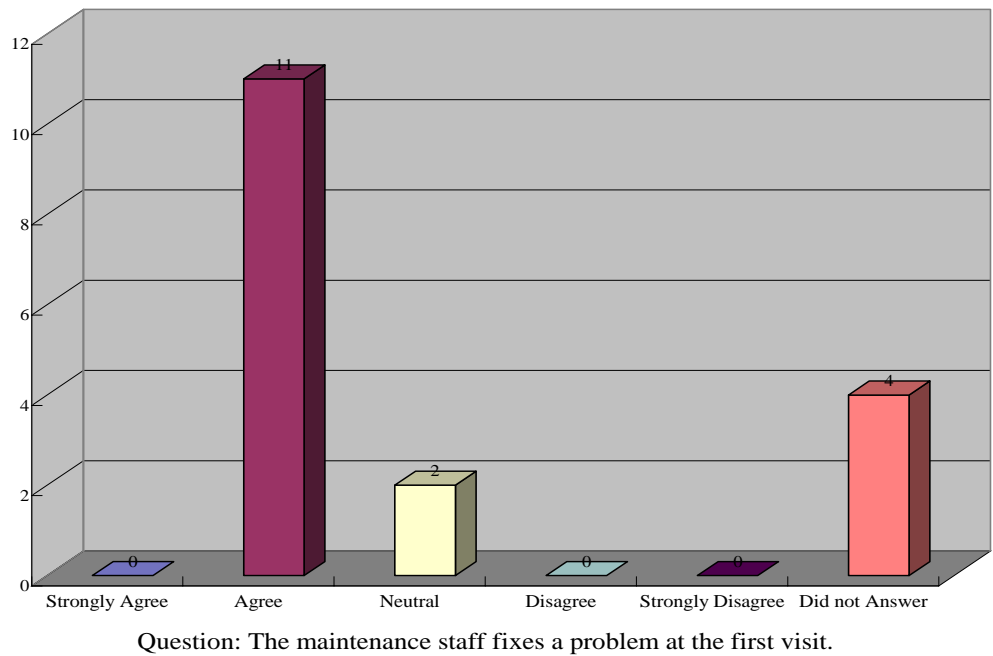


Fig. 40. Tendency of repair

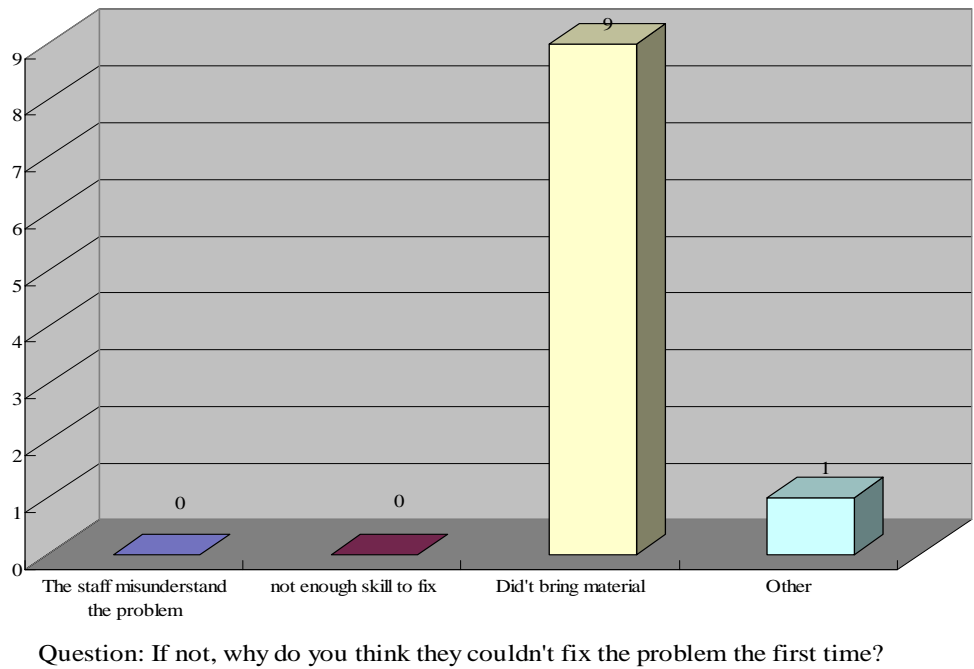
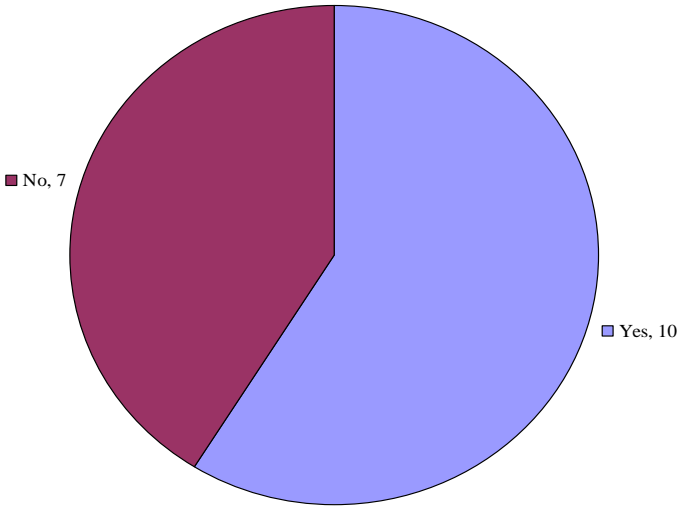
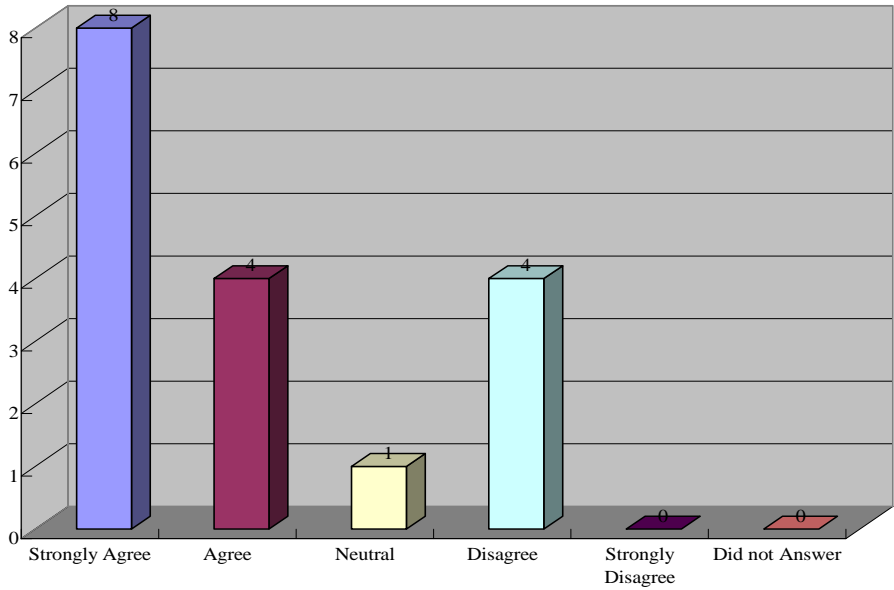


Fig. 41. The reason that the staff could not fix the problem on the first visit



Question: Have you been notified about the process of service request?

Fig. 42. Notification of the process of service request



Question: If this system is used for real, would you prefer it to other communication methods?

Fig. 43. Preference of communication

The analyses of the survey results reflect that residents are willing to use the WGSR system to request service, to view maintenance history, and to see the status of work orders. The population of this research was limited to a very small group and therefore has limited reliability. Nevertheless, the results provide a significant step toward demonstrating the efficacy and need for a graphical user method of placing service requests.

3. Overall Comment from the Subjects

- Any comments/feedback about the design of the testing model and the visual interface of the model.

Answers for the above comments are summarized in Table 4.

Table 4. Open comment for design and interface

Positive feedback	Negative feedback
<ul style="list-style-type: none"> – This is an excellent model. I would really like to use this design if it is available in an actual situation. – It's a good design. – It is nice. – It looks cool. – This is a good Web based system for maintenance. – I hope this graphic service request system could be adopted by the university apartments in the near future. 	<ul style="list-style-type: none"> – More specific problems should be described. – 3-D Apt. model might be better. – There are some issues with the accuracy of the floor plans (balcony's are missing and there are significant differences from first and second floors).

As mentioned by the participants, the researcher consider 3D models in the initial stages by using virtual reality modeling language (VRML) or free AutoDesk DWF viewer. However, AutoDesk DWF viewer software must be installed by the user prior to use. Moreover, AutoCAD Revit, which enables each component's drawing on a DWG file to hold information, should be installed and synchronized with the DWF viewer for the FM organization (Fig. 44). The VRML or DWF viewer is software intense for the user's computer and the main server, and AutoCAD Revit is very expensive to install for

FM administration. Therefore, the researcher draws the floor plan in form of a perspective and isometric drawing to compensate for the disadvantage of 2D drawing.

- Is there anything you would like to have in the tool that was not there?
 - Maybe you can consider including another contact method with the maintenance office, such as phone number or email.
 - Phone no. of maintenance office.

Because this research tested the concept of a graphic service request, the other contact information could not be given to residents. For application in a real service context, alternate contact information for maintenance staff should be provided.

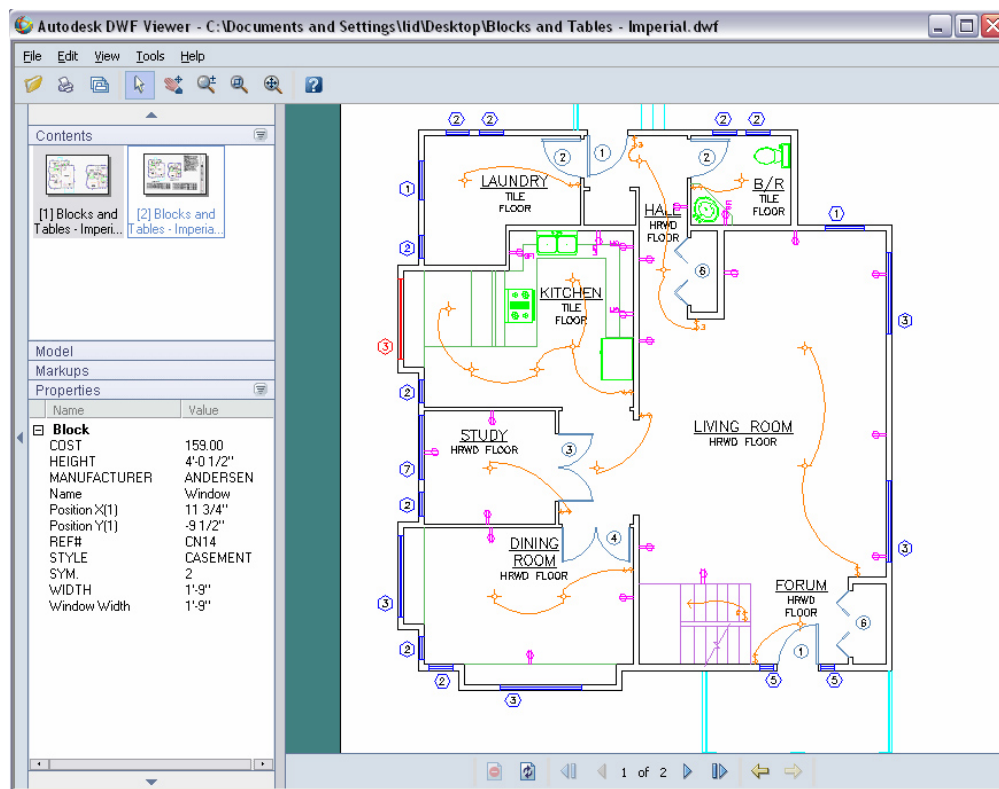


Fig. 44. AutoDesk DWF viewer synchronized with AutoCAD Revit

- Did you enjoy working with his tool and would you like to continue using this tool?

Answers for above question are summarized in Table 5.

Table 5. Open comment for preference

Positive feedback	Negative feedback
<ul style="list-style-type: none"> – Yes (five responses) – This is really easy to work with. I would like to continue using it. Much better and easier than phone requests. – It's very good. I'd like to use this kind of system. – Of course, this tool is really easy and convenient to use. – I think it's a great idea to use this graph-based service request system on the Web and I'd love to use this tool. 	<ul style="list-style-type: none"> – I am not sure because it is taxing to turn on a computer whenever I need to request maintenance. I will use the telephone rather than the Internet when I need to ask for help from the maintenance office. – I guess not. – I was wondering if all residents have access to a computer at home and can report problems. If it is an emergency then the telephone is the best method to communicate.

CONCLUSION

The WGSR system uses information and Internet technology to enhance resident satisfaction and apartment maintenance. The graphic interface allows residents to report correct service requests and to view the status of their work order. WGSR enables FM staff to recognize and diagnose problems accurately. It helps FM organizations manage service requests and set a compatible maintenance schedule.

Answer for Hypotheses

Hypothesis 1:

There exist communication issues that cause residents to hesitate to report problems and create obstacles for FM organizations to recognize those problems correctly.

Through the survey, 53% of residents indicated that they previously encountered communication problems with FM departments or property managers. They hesitated to report issues because of difficulty explaining them, time limitations, or the absence of FM staff. Residents mentioned that FM staffs are unable to prepare and bring the material needed to fix problems sometimes. Recognition of problem correctly in the first place avoids these inefficient and redundant activities. Results from experiments show that all of the residents who log into the system succeeded in requesting services.

Hypothesis 2:

Residents will prefer to use the Web-based Graphic Service Request System to submit a request for services.

The results of the experiment indicate that 70% of occupants prefer to use the WGSR system for reporting and tracking service requests instead of other communication methods such as phone calls. This result indicates that WGSR could decrease the effort involved in placing and receiving phone calls for service requests, as well as the subsequent input of information into a database. As information and Internet technology has advanced, people have begun to request services through the Internet anywhere and anytime with personal computers. Information and Internet technology makes it possible for everyday services and requests to be automated and to minimize human intervention. There are no other service request systems using graphical interfaces at present. This system addresses the disadvantage of the text-based service request systems which needs information to be input manually. The analysis of the results shows that the WGSR system was efficient and convenient in several fields which include comprehensibility, navigability, simplicity, clarity, compatibility, and graphically appealing.

The evidence verifies that one can establish, develop, and implement a Web-based graphic service request system for improving FM. Combination of location, part, and types of problem ID set one service request record. This could simplify the explanation of problems associated with phone calls or walk ins. The maintenance database was centralized and efficiently used over the network. The result of the survey validate that graphic service requests could popularize the WGSR system for customer use.

Supporting an easy-to-use customer interface is important to promote the

frequency of system use for service requests. Unifying the reporting process into one application improves the quality of data and response time for service requests.

Initial requests from residents were recorded directly and this prohibits the drop of recording information from phone calls and missing information from transferring data. It improves the quality of information and communication between residents and FM organizations.

Further Discussion

The scope of this research is to present and demonstrate the concept of a graphic service request system for residents to use. Graphic service requests are recorded text-based style to the FM organization on the fly. To improve the system for use in real facility management organizations, it should be decided whether service requests are showed in a graphic-based or text-based fashion to FM staff. To determine resident's service request patterns and deliver better service, a large number of participants and data are essential to conclusively demonstrate the usefulness of the WGSR system. Likewise, the system was implemented only for the test of residents. To maximize the system, it should be tested from the point of view of FM staff. Such testing would target all parties involved in using the WGSR system, thereby indicating the feasibility of the system for both residents and staff.

The floor plan used in the WGSR system could be substituted by a real photo image or a 2D image with HTML image tags. Therefore, it could be used in any type of

building; this is especially useful for apartments, hospitals, and offices where the same type of unit plan is repeated within the structure.

Although users prefer to use the WGSR system for service requests, they still need to use the telephone to report emergencies, etc. Such service requests are possibly too urgent to depend on a Web-based system for a quick response. Therefore, further research investigations into the system should integrate information from multiple communication methods into a single database which can recognize emergency situations using information retrieval algorithms or artificial intelligence in order to notify FM staff quickly so they can respond appropriately.

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APPENDIX A

IRB DOCUMENTATION



Office of the Vice President for Research
Texas A&M University

Office of Research Compliance

Academy for
Advanced
Telecommunication
and Learning
Technologies

Center for Information
Assurance and Security

Comparative Medicine Program

Institute for
Scientific Computation

Institute for Telecommunications
and Information Technology

Integrative Center for
Homeland Security

Microscopy Imaging Center

Office of Business Administration

Office of Distance Education

Office of Graduate Studies

Office of Organizational
Development and Diversity

Office of Proposal Development

Office of Sponsored Projects

Professional Development Group


Technology Commercialization
Center

Texas A&M University
Research Park

October 4, 2005

MEMORANDUM

To: Kwang Jun Lee
Architecture
MS 3137

From: Ms. Sharon Alderete, CIP 
IRB Program Coordinator

Subject: IRB Request for Exemption

Protocol Number: 2005-0488

Title: Web-Based Service Request System for Facility Management of
Apartment


The Institutional Review Board (IRB) has determined that the referenced protocol application meets the criteria for exemption and no further review is required. However, any amendments or modifications to the protocol must be reported to the IRB and reviewed before being implemented to ensure the protocol still meets the criteria for exemption.

This determination was based on the following Code of Federal Regulations:
(<http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.htm>)

<input type="checkbox"/> 46.101(b)(1)	<input checked="" type="checkbox"/> 46.101(b)(2)	<input type="checkbox"/> 46.101(b)(3)
<input type="checkbox"/> 46.101(b)(4)	<input type="checkbox"/> 46.101(b)(5)	<input type="checkbox"/> 46.101(b)(6)

Comments:

If you have any questions regarding this protocol application or the review process,
please contact the IRB office at (979)458-4067.



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FAX 979.862.3176

INFORMATION SHEET

Information Sheet

(This sheet will be posted on the first page of Web-based Service Request System)



Web-based Service Request System by Using Graphic User Interface for Facility Management of Apartment

You have been asked to participate in a research study about Internet service request system for apartment maintenance. You were selected to be a possible participant because you live Hensel terrace or college view apartment. A total of 20 people have been asked to participate in this study. The purpose of this study is that residents report problems of house more easily and correctly through the Internet so that facility management department delivers high quality service.

If you agree to be in this study, you will be asked to use Web-based service request system and answer questionnaire about its concept, interface and usability. This study will only take 15 minute to perform. There are no risks associated with this study at all. There is no payment to participate in this research.

This study is confidential. The records of this study will be kept private. No identifiers linking me to the study will be included in any sort of report that might be published. Cookies will not be placed on the subject's computer by accessing the survey. Research records will be stored securely and only Kwang J. Lee will have access to the records. Your decision whether of not to participate will not affect your current or future relations with Texas A&M. If you decide to participate, you are free to refuse to answer any of the questions that may make you uncomfortable. You can withdraw at any time without your relations with the university, job, benefits, etc., being affected. You can contact Principal Investigator (Kwang J. Lee, (979) 571-6098, architect@tamu.edu) or Research Advisor (Miranda Valerian, (979) 845-3033, miranda@archone.tamu.edu) with any questions about this study.

This research study has been reviewed by the Institutional Review Board- Human Subjects in Research, Texas A&M University. For research-related problems or questions regarding subjects' rights, You can contact the institutional Review Board through Ms. Angelia M Raines, Director of Research Compliance, Office of Vice President for Research at (979) 458-4067 (araines@vprmail.tamu.edu).

APPENDIX B

THE WEB-BASED GRAPHIC SERVICE REQUEST SYSTEM FOR FACILITY MANAGEMENT OF APARTMENTS

Post task Questionnaire

The following information regarding your identity will be confidential, and used by the Principal Investigator only to relate these to your scores in the use of the developed testing model and to complete the evaluation of the testing model. Please complete the following questionnaire by checking the best answer out of the choices presented for each question:

Please complete the following questionnaire circling the best answer out of the choices presented for each question: You may choose to not answer a question, for whatever reason.

I. WGSR: Concept and Interface

1. The Internet reporting webpage was easy to understand
Strongly Agree 1 2 3 4 5 Strongly disagree
2. The Internet reporting webpage was easy to navigate
Strongly Agree 1 2 3 4 5 Strongly disagree
3. The visual interface of this Internet reporting webpage model was appealing
Strongly Agree 1 2 3 4 5 Strongly disagree
4. this Internet reporting webpage was very easy to learn
Strongly Agree 1 2 3 4 5 Strongly disagree
5. Form buttons are labeled meaningfully
Strongly Agree 1 2 3 4 5 Strongly disagree
6. Overall experience of graphics on this Internet reporting webpage was good
Strongly Agree 1 2 3 4 5 Strongly disagree
7. This Internet reporting webpage required lot of effort to request service
Strongly Agree 1 2 3 4 5 Strongly disagree
8. History and status of your service requests of this Internet reporting webpage were satisfactory
Strongly Agree 1 2 3 4 5 Strongly disagree

9. Have you had previous experience with similar Internet reporting Webpage?
 a) Yes
 b) No

II. Web-Based Service Request System: Its Usability

1. How do you give notice to lease office if you have problems in your home use?
 a) Telephone
 b) Visiting lease office
 c) Ask another person to report
 d) Apartment Web page
 e) E-mail
 f) Other
2. If you selected "Apartment Webpage" in question No.1, How often have you used internet homepage to request service?
 a) Usually
 b) Very Often
 c) Often
 d) Once
 e) Never
3. Do you encounter any problems in communicating with lease office?
 a) Yes
 b) No
4. Have you ever hesitated to report any problems you have?
 Strongly Agree 1 2 3 4 5 Strongly disagree
5. If yes, what is the reason for hesitating?
 a) Due to late time
 b) Hard to explain
 c) Don't remember office phone number
 d) Absence of staff
6. The maintenance staff fixes a problem at first visit.
 Strongly Agree 1 2 3 4 5 Strongly disagree
7. If not, why do you think they couldn't fix the problem the first time?
 a) They misunderstand the problem
 b) Not enough skill to fix
 c) Didn't bring material

d) Other

8. Have you been notified about the process of service requests?
 - a) Yes
 - b) No
9. If this system is used for real, would you prefer it to other communication methods (telephone, stop by office, etc)?

Strongly Agree 1 2 3 4 5 Strongly disagree

III. Detailed Feedback

1. Any comments/feedback about the design of the testing model and the visual interface of the model.
2. Is there anything you would like to have in the tool that was not there?
3. Did you enjoy working with this tool and would you like to continue using this tool?

VITA

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EDUCATION

M.S. in Architecture, Texas A&M University, College Station, TX. Aug 2006
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Architecture Information Management
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19th Division ROK Air Force, Choongju, Korea
Jun. 1999 ~ Oct. 2001
An airman first class, Facility Operation & Maintenance staff

Internship, MINWOO Architecture Studio, Seoul, Korea.
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PUBLICATIONS AND PRESENTATIONS

Jin Su Jeong, Kwang Jun Lee and Valerian Miranda. 2005. Web-based service request & feedback system: the lifecycle management as continuous customization of facility information, *1st International Conference on Construction Engineering and Management, Seoul, Korea*

Poster Presentation. April 2005. Web-based Service Request System for Operation and Maintenance of residential complex, directed by Dr. Valerian Miranda. Student Research Week Competition in Texas A&M University, College Station, TX.